This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

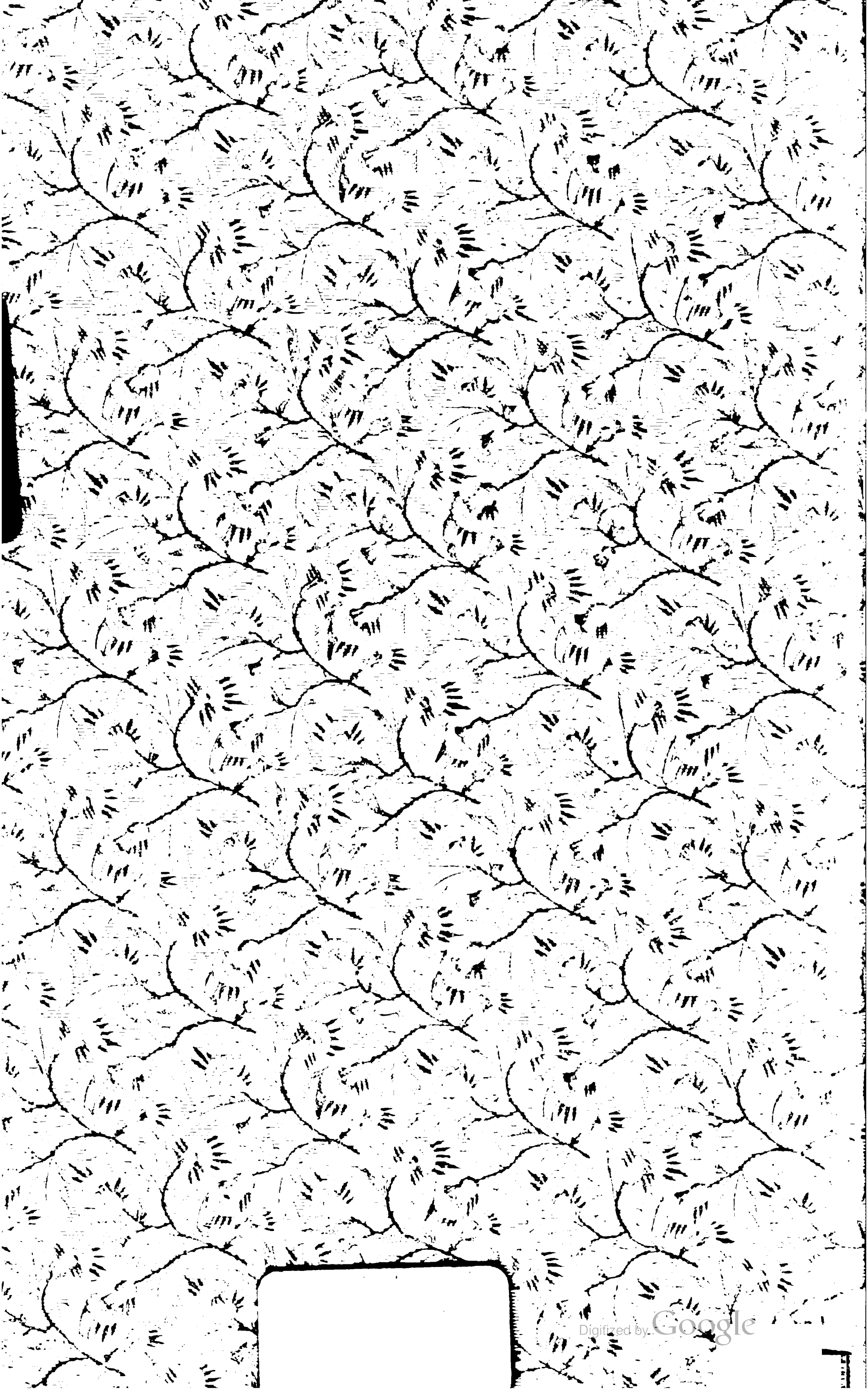
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

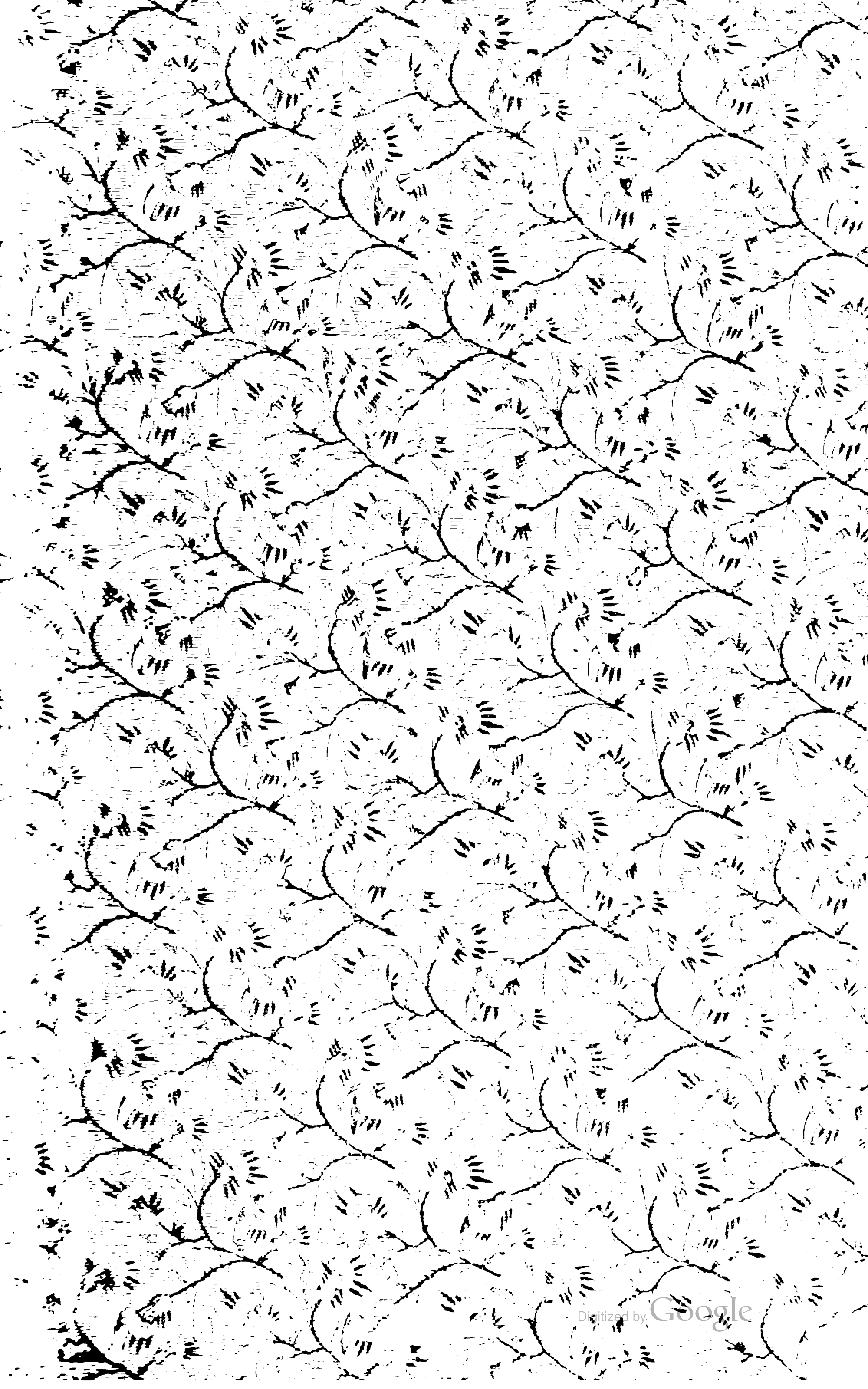
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`





557.4
N42

Black cloth
Covers m

J C

5 2862

ANNUAL REPORT

Geological Survey
of New Jersey
annual reports
1869–1873.

OF THE

STATE GEOLOGIST

OF

NEW JERSEY,

FOR 1869.

TRENTON, N. J.:
PRINTED AT THE TRUE AMERICAN OFFICE.
1870.

208851

GEOLOGICAL SURVEY OF NEW JERSEY.

BOARD OF MANAGERS.

His Excellency Theodore F. Randolph, Governor and *ex officio* President of the Board.

Hon. Andrew K. Hay,	*First Cong. District.*
Charles E. Elmer, Esq.,	
Hon. William Parry,	*Second Cong. District.*
Hon. Henry S. Little,	
Selden T. Scranton, Esq.,	*Third Cong. District.*
Henry Aitkin, Esq.,	
Hon. Andrew B. Cobb,	*Fourth Cong. District.*
Abram S. Hewitt, Esq.,	
William M. Force, Esq.,	*Fifth Cong. District.*
Joseph P. Bradley, Esq.,	

STATE GEOLOGIST.

GEORGE H. COOK.

To His Excellency, Theodore F. Randolph, Governor of the State of New Jersey, and President of the Board of Managers of the State Geological Survey:

SIR:—I have the honor herewith to submit my annual report, on the work of the Geological Survey, for the year 1869.

With high respect and esteem,
Yours truly,
GEO. H. COOK,
State Geologist.

RUTGERS COLLEGE,
New Brunswick, Dec. 28, 1869.

REPORT.

DISTRIBUTION OF THE GEOLOGY OF NEW JERSEY.

At the date of the last report, the Geology of New Jersey with the accompanying maps was passing through the press. Two thousand copies of the work were printed, and of these one thousand copies were bound. Since then five hundred more have been bound. The remainder are still in sheets. One thousand copies of the accompanying maps were colored and put up in portfolios, and the engraved stones were kept for further use. Since that time five hundred additional sets of the maps have been printed and prepared for distribution.

A large Geological Map of New Jersey on a scale of two miles to one inch, was also prepared, and two hundred copies were printed and colored. One hundred of these have been backed and mounted and the second hundred must soon be prepared, as the first is nearly gone.

According to your instructions, copies of the Geology and Maps have been given to various public officers and institutions, and others have been sold at the cost of paper, printing and binding. The price in this way put upon the book was very low, so low indeed that it left nothing to cover the cost of selling, and, of course, no inducement for booksellers to engage in its sale. The explanation you gave for this very low price, viz: that it saved from any invidious distinctions in distributing a few copies among the many who might desire it, and also placed it at a cost so moderate that any who choose could buy it, appears to be entirely satisfactory. There is no trouble in selling out the entire edition to booksellers, who would then be able to put it at a price which would pay them a profit. As the results of the Survey are intended for the benefit of the people of the State, it is undoubtedly best to continue the books at the same price as heretofore, for some time to come. It may be desirable to put them in the hands of booksellers, and raise the selling price, after the offer of them at the present rates has been continued for a sufficient time. The prices at which they have been sold are given in the accompanying descriptive list:

Geology of New Jersey, 899 pages large octavo, illustrated by 108 photolithographic engravings and woodcuts, and six mine maps; and accompanied by a portfolio containing the following maps, in sheets:

1. Azoic and Paleozoic Formations, including the Iron-ore and Limestone districts; colored. Scale 2 miles to an inch.
2. Triassic Formation, including the Red Sandstone and Trap-rocks of Central New Jersey; colored. Scale 2 miles to an inch.
3. Cretaceous Formation, including the Greensand Marl Beds; colored. Scale 2 miles to an inch.
4. Tertiary and Recent Formations of Southern New Jersey; colored. Scale 2 miles to an inch.
5. Map of a Group of Iron Mines in Morris county; printed in two colors. Scale 3 inches to 1 mile.

6. Map of the Ringwood Iron Mines; printed in two colors. Scale 8 inches to 1 mile.

7. Map of the Oxford Furnace Iron-ore Veins; colored. Scale 8 inches to 1 mile.

8. Map of the Zinc Mines, Sussex county; colored. Scale 8 inches to 1 mile.

Price of the book and portfolio of maps, $6.00.

Geology of New Jersey, as above, without portfolio of maps, but containing a folded and colored map of the State, on a scale of 5 miles to 1 inch. Price $4.00.

Single copies of either of the above maps, colored and in sheets, 50 cents.

Geological Map of New Jersey, on a scale of 2 miles to one inch; colored and mounted on rollers. It gives the Geology of the State the same as Maps 1, 2, 3, 4, in the portfolio, and is essentially these combined in one map. Size 5½ by 7½ feet. Price $8.00 per copy.

The prices are fixed to merely cover the cost of paper, printing and binding; the expenses of the Survey and preparing book and engravings being paid by the State.

These publications can be had from Prof. Geo. H. Cook, State Geologist, New Brunswick, on remitting the price, or through the booksellers.

The books are also kept for sale at these prices by William T. Nicholson, of Trenton; Sampson & Morgan, of New Brunswick; M. R. Dennis & Co., of Newark, and D. Van Nostrand, of New York city.

The work is in the following public libraries, where it can be consulted:

In all the State libraries; in some other of the large public libraries in different parts of the United States, and in the following libraries in New Jersey and in the adjacent cities of New York and Philadelphia, viz:

New Jersey State Normal School;
New Jersey Model School;
Farnum Preparatory School;
West Jersey Academy;
Pennington Seminary;
Drew Seminary;
Newark High School;
Newark Academy;
Rutgers College;
Burlington College;
Princeton College;
Princeton Theological Seminary;
Theological Seminary of Reformed Church;
New Jersey Historical Society;
Seton Hall;
Newark Library;
Burlington County Lyceum;
Winslow Lyceum;
Camden Library;
Salem Library;
Dennis Library at Newton;
Tuckerton Library;
Millville Library;
Bricksburg Library;
Yardleyville Library;
Burlington Library;
Rancocas Library;
Woodbury Library;
Young Men's Christian Association of Trenton;
Young Men's Christian Association of New Brunswick;

Young Men's Christian Association of Hackettstown;
Young Men's Christian Association of Jersey City;
Home for Disabled Soldiers;
Home for Soldiers' Children;
American Iron and Steel Association, Philadelphia;
Philadelphia Library;
American Philosophical Society, Philadelphia;
Academy of Natural Sciences, Philadelphia;
New York Historical Society:
Astor Library, New York;
Mercantile Library, New York;
Cooper Union Library, New York;
Mechanics' and Tradesmen's Library, New York;
New York Lyceum of Natural History;
American Institute, New York;
American Geographical and Statistical Society, New York;
Long Island Historical Society, Brooklyn;
University of New York;
Columbia College, New York.

A copy of the Geology and two of the large mounted maps, were also offered to each of the County Clerks for deposit in their offices; one of the maps to be hung in the court room, and the other in the Clerk's office. Under this offer the book and maps have been sent to the counties of

Atlantic,
Bergen,
Burlington,
Camden,
Cape May,
Cumberland,
Gloucester,

Mercer,
Middlesex,
Morris,
Passaic,
Somerset,
Union,
Warren,

And they will be sent to

Essex,	Monmouth,
Hudson,	Ocean,
Hunterdon,	Salem,
Sussex,	

on application from the County Clerk.

It has also been supplied to the following Farmers' Clubs for their Libraries:

Progressive Farmers' Club, Mt. Laurel;
Vineland Agricultural Society;
Somerset County Farmers' Club;
Seaville Farmers' Club;
Union County Farmers' Club.

And it will be furnished to any others in the State, which give promise of permanency, on their application.

It is desirable that every public library in the State should have a copy of the work, and it will be forwarded on application from the proper authority;

EXPENSES.

The expenses of the survey for the year have been $3,977.14, a sum considerably within the amount appropriated.

CONTINUATION OF THE SURVEY.

In accordance with the provisions of the law of last winter (1869,) the survey is continued.

The State Geologist appointed in the original law of 1864, continues his supervision of the survey. The Assistant Geologist, Professor J. C. Smock, is for the present, detached from the work, to extend his knowledge of

Geology and Metallurgy, by study and travel in Europe. It is expected that the survey will have the benefit of his studies and experience in preparing the report on the Iron and Zinc Ores.

Edwin H. Bogardus, the chemist of the survey, has been steadily engaged in the laboratory. He has completed the analysis of a large number of soils, in preparation for that part of the work, and has in addition analysed many fertilizers, clays, marls, &c., and is making experiments on the chemical changes that take place in various composts and rotting manures.

Edward A. Bowser, a graduate of our State Agricultural College, has been employed since the middle of September in a survey of the Newark and Elizabeth undrained marshes, and the reclaimed marshes of Salem, and a survey of Passaic river, with its branches, the Whippany and Rockaway, above Little Falls.

PLAN OF THE WORK.

The chief operations of the Geologist and his assistants, will be directed to putting the results of the survey in form for practical use. In carrying out this leading idea the investigations and conclusions will be arranged and published under the following general heads.

1. *Fertilizers found in the State, and the means of making them more quickly and generally useful.*

Under this head will come the results of those inquiries, investigations and experiments, which are so much needed for our advancing agriculture. The State has inexhaustible supplies of phosphatic and calcareous marls, of rich alluvial and marine deposits, and of fish and other fertilizers from the sea and its bays, sounds and creeks, which our farmers should know how to use at the earliest possible time, and in the most economical way. There is also an enormous waste of fertilizers in our towns and cities, which can be saved with great benefit, to both public health and agricultural productiveness.

2. *On the Marshes, and Tracts of Land subject to Protracted Freshets.*

There is a large area of land of this kind in the State, the improvement of which is demanded by the public interests. It is held in small tracts, so that the owners are not in power to carry out plans for its drainage; and information regarding its formation and condition, its capabilities and the means for its reclamation, is of large and general importance.

3. *On the Soils of the State, their origin, chemical and physical properties, distribution, and suggestions for their most productive management.*

With a full third of the State unimproved, and in condition to be successfully treated, by the intelligent use of capital, it is plain that this subject should be made a matter of scientific investigation.

4. *On the Iron and Zinc Ores of the State.*

In the *Geology of New Jersey* this subject is taken up in connection with the rock formations of the State. The origin of these ores, the chemical changes they have undergone, their rock and mineral associations, the geological changes to which they have been subjected, their present occurrence, and the modes of searching for, and of mining, are all treated of in that work, but under different general heads. They deserve a distinct and separate examination and description.

5. *Additions to the Scientific and Economical Geology of the State.*

Every year is adding to the stock of knowledge upon these topics, and it is of importance to have this knowledge made public as extensively and as early as possible.

I. FERTILIZERS FOUND IN THE STATE, AND THE MEANS OF MAKING THEM MORE QUICKLY AND GENERALLY USEFUL.

The mineral and other fertilizers found in the State have been described in much detail in the Geology of New Jersey, and in the Annual Reports of the Agricultural College. I present here some analyses of Greensand Marl, and tables for their valuation as fertilizers:

ANALYSES.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Phosphoric Acid	1.14	3.58	2.58	3.87	1.33	1.02	2.30	2.24	2.69	2.56
Sulphuric Acid	0.14	0.97	1.89	.31	.00	.27	.00	.39	.26	0.22
Silicic Acid	38.70	53.15	59.80	54.75	46.03	50.23	57.67	50.80	49.40	51.50
Carbonic Acid	6.13	......	.....	......	....	.....	......	......	.....	.....
Potash	3.65	3.75	4.25	4.11	5.67	6.32	3.53	5.18	6.31	4.62
Lime	9.07	3.27	2.97	5.46	2.01	1.40	1.26	2.13	2.52	1.26
Magnesia	1.50	1.75	2.00	2.99	3.47	3.45	3.67	3.54	3.24	3.95
Alumina	10.20	8.79	6.00	6.46	7.86	7.94	10.10	8.77	8.90	6.01
Oxide of Iron	18.63	15.94	11.98	15.20	25.23	20.14	14.16	17.63	17.11	21 04
Water	10.00	8.98	8.32	6.85	8.40	9.00	7.25	9.66	9.10	7.39
	99.16	100.18	99.79	100.00	100.00	99.77	100.00	100.34	99.53	98 55

(1) Is an average of the variety of marl most largely used in eastern Monmouth. It is not particularly rich in phosphoric acid, but is remarkable for containing from 10 to 20 per cent. of carbonate of lime in fine powder. In the neighborhood of this marl where it costs little more than the cartage, a great deal is used, which is much poorer than this; but there is no trouble in finding millions of tons of this quality. It is used in larger quantities per acre than the other varieties, and is remakable for the permanent improvement it makes in the soil.

(2) Is an average of five analyses of the *Squankum* marl, and may be taken as a fair sample of that noted fertilizer. The specimens for analysis were taken from five different pits, and each was judged to be an average of the whole digging.

(3) Is an average of the marl dug by the Squankum Marl Company. It is supplied of this quality along the entire line af the Raritan and Delaware Bay Railroad, and also at Port Monmouth for shipping. This marl is dug from the green and ash layers of the upper marl bed. The ash marl is more clayey and poorer than the green marl. But the mixture of the two is a good fertilizer, as both experience and the analysis show.

(4) Is an analysis of an average sample taken from a pile of 100 tons of marl sent by the Freehold and Squankum Marl Company to New Brunswick. A sample carefully averaged by my assistant, Mr. Bogardus, at the pits of the Company, yielded $4\frac{58}{100}$ per cent. of phosphoric acid.

(5) Is from the pits of the Cream Ridge Marl Company. The analysis is from an average specimen taken at the pits by my assistant, Mr. E. H. Bogardus.

(6) Is from the pits of the Pemberton Marl Company.

It was from a sample prepared by J. C. Gaskill, Superintendent, and was averaged by cutting an uniform slice from the top to the bottom of the bank of marl, and carefully mixing the whole.

(7) Is an analysis from the pits of the Vincentown Marl Company. The sample I believe to be a fair average.

(8) Is an analysis of marl dug at White Horse, on the line of the Camden and Atlantic Railroad. An abundant supply of this marl is to be had; and it is the source from which it can be easiest sent to all of Atlantic county, and the country along the Camden and Atlantic Railroad.

(9) Is the analysis of a carefully averaged sample of marl from the West Jersey Marl Company's pits at Barnsboro'. Several hundred tons of it are sent over the West Jersey Railroad every day, to supply the wants of farmers in the country traversed by that road and its branches. The growing demand for this marl is the best proof of its good quality. It is from the green layer of the middle marl bed.

(10) Is an analysis of an average sample of marl from the pits of Dickinson Brothers, at Woodstown. This marl has an excellent reputation. From 10,000 to 15,000 tons are sold annually to the neighboring farmers, and hauled away in wagons.

Tables for Calculating the Value of Marl, and for Comparing it with other Fertilizers.

TABLE I.

Stockhardt's Table of the gold values of the chief elements in fertilizers, copied from Caldwell's Agricultural Chemical Analysis.

Form in which the substance exists in the fertilizer.	PRICE PER LB. IN GOLD.
Phosphoric Acid, soluble in water as in super phosphate,	$ .12½
Phosphoric Acid in Peruvian guano,	.10
Phosphoric Acid in steamed bones finely ground, in rape cake, poudrette, etc.,	.08¼
Phosphoric Acid in Baker guano,	.07½
Phosphoric Acid in coarse bone-meal, fresh human urine, etc.,	.07
Phosphoric Acid in coarse broken bones, fresh human excrements, stable manure, etc.,	.05½
Potash as potassic sulphate,	.06½
Potash as potassic chloride and in other forms,	.05½
Nitrogen easily soluble, or in compounds that are readily decomposed, as in ammonia nitrate, dried blood, meat, urea, etc.,	.22
Nitrogen in finest bone-meal, poudrette, etc.,	.19½
Nitrogen in coarse bone-meal, rape-meal, horn-meal. wood-dust, fresh human urine, etc.,	.16½
Nitrogen in coarse broken bones, horn shavings, woolen rags, fresh human excrements, stable manure, etc.,	.13¾

TABLE II.

The English valuation of these substances is given in Vol. 20, p. 74 of the *Country Gentleman*, by Dr. Voelcker, Consulting Chemist to the Royal Agricultural Society of England. It is as follows, allowing two cents for each English penny :

1. Nitrogen in the form of ammonia,	16 cts.	℔ ℔
2. Nitrogen in animal or vegetable substances,	12	"
3. Nitrate of Soda,	4	"
4. Phosphate of Lime, (bone earth),	2	"
or Phosphoric Acid alone,	4	"

		PRICE PER LB IN GOLD.
5.	Soluble Phosphate of Lime, or Bi-Phosphate of Lime,	9 cts. ℘ ℔
6.	Salts of Potash,	2½ "
7.	Gypsum.	2 cts. ℘ 10 ℔
8.	Lime,	2 " 12 "
9.	Carbonate of Lime,	2 " 25 "
10.	Magnesia,	2 " 10 "
11.	Organic matter, (humus),	2 " 20 "
12.	Common Salt	2 " 10 "

PRICES BY PROF. JOHNSON.

Professor S. W. Johnson, of New Haven, Connecticut, in a report to the Secretary of the State Board of Agriculture on Commercial Manures, made last winter, estimates the gold value of potash, at 4 cents a pound; soluble phosphoric acid at 12½ cents; insoluble phosphoric acid 4½ cents, and nitrogen 17 cents. Professor Johnson is the best authority on this subject, in our country.

By the use of these tables the approximate value of the marls may be calculated.

The phosphoric acid is combined mostly with lime, though a little of it is probably combined with oxide of iron. The phosphates of lime and iron are both in very fine powder, or else in soft grains, so that while it cannot be quite as soluble as superphosphate, it is certainly much more soluble than any bone-dust. Judging from Stockhart's table of prices and qualities of fertilizers, I think the phosphoric acid in our marl should be rated between that in guano, which is 10 cents a pound, and that in steamed bones, which is 8¼ cents, and therefore propose for it in our calculations, 9 *cents gold as the price per pound.* The potash in the marls is combined with silicic acid, and the compound, silicate of potash, is not readily soluble in water. Johnson's price, 4 cents a pound, is for soluble potash as it is found in carbonate of potash (pearl-ash,) sulphate of potash, muriate of potash (chloride of potassium,) or crude potash, The potash in the marls is, however, dissolved out slowly by the action of water containing carbonic acid, and so becomes available. Until there is some more decided reason for fixing a different price, I will set down its value at 2 cents a pound.

The value of the several marls given in the above table would then be easily made. Considering the phosphoric acid and potash as the only parts of the marl worth transportation, their values range from $3.50 to $8.50 a ton ; and I believe, that in comparison with the prices paid for concentrated manures, they are worth that price to the farmer. The cost must be taken when they are upon the soil, and not, as might be thought, when in store. I am confirmed in my opinion of their value by the testimony of successful farmers, who have used them for twenty years or more; and who assure me, they can better afford to incur an expense from $5 to $8 a ton, than to farm without them or to use any other purchased fertilizers; and also confirmed by my own observation in all parts of New Jersey where marl has been used. It gives lasting fertility to the soil. While all other fertilizers are exhausted and the soils become poor, I have to see the first field that has ever been well marled that is now poor. One instance was found where poor and sandy land was marled more than thirty years ago, and has ever since been tilled without manure, and not well managed, which is still in good condition. Occasionally marled fields are seen that do not grow crops as large as they once did, but all their fertility is immediately restored by a dressing of lime ; an effect which could not have been produced by the lime on unmarled land.

I am averse to having the valuation on the various green sand marls which are used in the State, based on the phosphoric acid and potash only in the above table of analyses ; for I do not think they are the only useful substances in it. The fine carbonate of lime in No. 1, is certainly of too much value to be neglected. And the sulphate of lime (gypsum) in many of them is enough to be very beneficial to crops. The valuation, however, seems to be demanded, and this is the best approximation I can make.

Table showing the estimated value of the Phosphoric Acid and Potash in the ten samples of Marl analysed.—Marl contains no Ammonia.

No	Phosphoric Acid.			Potash.			Total Value per ton
	Per cent.	Per Ton. Pounds.	Per Ton. Value.	Per cent.	Per Ton. Pounds.	Per Ton. Value.	
1	1.14	22.8	$2 05	3.65	73.0	$1 46	$3 51
2	3.58	71.6	6 44	3.75	75.0	1 50	7 94
3	2.59	51.6	4 64	4.25	85.0	1 70	6 34
4	3.87	77.4	6 96	4.11	82.2	1 64	8 60
5	1.33	26 6	2 39	5.67	113.4	2 27	4 66
6	1 02	20.4	1 83	6.32	126.4	2 53	4 36
7	2.33	46.6	4 19	3.53	70.6	1 41	5 60
8	2.24	44.8	4 03	5.18	103.6	2 07	6 10
9	2.69	53.8	4 84	6.31	126.2	2 52	7 36
10	2.56	51.2	4 60	4.62	92.4	1 85	6 45

Other Fertilizers in Comparison.

An average sample of *Peruvian Guano* may have its value calculated in the same way, and if we use Johnson's prices, considering also 14 cents for ammonia to be equal to 17 cents for nitrogen, and the phosphoric acid as equal to soluble, the result is:

For 15 per cent. ammonia, or 300 pounds per ton,	$42 00
For 5 per cent. potash, or 100 pounds per ton,	4 00
For 10 per cent. phos. acid, or 200 pounds per ton,	25 00
Total gold value for one ton, ...	$71 00

A first quality Super-Phosphate.

For 7. per cent. Ammonia, or 140 lbs per ton,	$19 60
For 6.5 per cent. Soluble Phos. Acid, or 130 lbs. per ton.	16 25
For 5. per cent. Insoluble Phos. Acid, or 100 lbs. per ton, ...	4 50
Total gold value per ton.	$40 35

Pure Raw Bone.

For 5 per cent. of Ammonia, 100 lbs. per ton,	$14 00
For 25 per cent. of Insoluble Phos. Acid, 500 lbs. per ton, ...	22 50
Total gold value per ton, ...	$36 50

Marl, and by this term I always mean greensand marl, unless it is otherwise expressed, is a mineral substance and not very easily or rapidly dissolved, and it does not appear to have any unusual power of absorbing ammonia. As part of the value of a fertilizer depends upon its solubility, it becomes of prime importance to the farmer to quicken the solubility of marl as much as possible. Composts of marl with lime, or barn-yard manure or guano, produce this effect, and where the experiment has been thoroughly tested by farmers, it has proved highly satisfactory.

Experiments are in progress to determine the chemical effects produced upon marl by composting, and some advance has been made; but the results are not yet complete enough for publication. Experiments and inquiries are also in progress, to see if any process can be devised for separating the phosphoric acid and potash from the mass of the marl, and so put in a more concentrated form for transportation to distant places, at less cost.

II. ON MARSHES AND TRACTS OF LAND SUBJECT TO PROTRACTED FRESHETS.

The marshes along the sea-shore, and tidal waters of the State, cover a large extent of surface. Nearly all of them are only waste ground, unproductive, unsightly, and directly under the eye of the public. These marshes, if reclaimed, would be the most productive farm lands in the State; and the location of some of them in the immediate vicinity of New York City, where land is high priced, is creating a necessity for their entire reclamation at an early day.

It is remarkable that these marshes should have so long remained unimproved, when the success and value of such improvements were so well understood. Marshes in the vicinity of Salem were dyked and drained as early as the year 1700, and from that time to the present, such works have been continued, and profitably managed in that part of the State. To those engaged in the Geological Survey, the contrast between the rich and productive lands in the dyked grounds of West Jersey, and the waste and forbidding wild marshes of East Jersey, was very striking and suggestive. We cannot do better. than to reprint here, an extract from the Geological Report of 1866, upon this subject. The successful improvement of the tide-marshes has been effected by shutting out the flow of the tide by embankments, and allowing the drainage to go on through sluices open only at low-water. By this means they are made dry, nearly to low-water mark. This work of banking in meadows has gone forward till the territory rescued from the sea amounts to 15,000 acres in Salem county alone besides large areas in Gloucester, Cumberland and Cape May counties. The largest tracts, and perhaps the most successfully managed, are in Salem county. The work has all been done by private enterprise ; the owners of a tract that could be profitably enclosed by a single bank, associating themselves together, and carrying the work forward under the terms of the banked-meadow law.

For the improvement of such a tract it is necessary to get the consent of the owners of two-thirds of the acres included in it, before the work can be begun. The ground is then surveyed, the banks located, and the courses of ditches and streams arranged by disinterested parties, or commissioners, who are generally men of large experience in the system of meadow drainage. The first operation is to dig on the site of the proposed bank a trench four feet wide and two spits deep. By this means the sod and grass roots of the surface are removed, and there is a firm foundation made on which to raise the proposed bank. Then a ditch twelve feet wide and three spits deep is dug outside the trench, and on the side next the creek or other body of water. This supplies the material for the bank. The spits thrown out of the ditch are cut into small pieces, and fitted tightly together in the bank by the packer, just as stone are laid up in a wall. This mud when well packed, forms a very strong and durable bank so long as it is kept moist. If it gets too dry the bank will crumble down. But this is rarely the case, since the flood tides generally keep the banks on the outside quite moist, and even wet. The general size of the Salem banks is four feet high above the meadow, eight feet wide at the bottom, and three feet on the top. The slope is commonly one-half to one on the inside, and nearly one to one on the outside. Exposed situations require larger and stronger banks, as, for example, those on the wearing or concave shores of streams, or where there is danger of high tides, from wind and water conspiring together. Thus at Finn's Point, on the Delaware, in Lower Penns Neck, where there is a very exposed shore for two or three miles along the river, the bank is ten feet high, twelve feet wide on top, and thirty feet at the bottom. The top is wide enough for a wagon road. The mud bank is also protected by a facing of stone on the river side, which secures the whole against any dangers from washing by heavy waves and high tides. By this bank an area of 1,200 acres has been safely protected at an unusually exposed point. In Cumberland county the banks range from three to seven feet high, and are built immediately on the surface af the meadow.

The banks are built at a little distance from the edge of the stream, leaving a strip of marsh outside a rod or more in width, for the protection of the bank and also for supplying the mud used in repairing. This space is called the *guard* or *shore.*

The cost of banking meadow varies greatly. Those built of mud from a ditch twelve feet wide and three feet deep, formerly cost $1 a linear rod; now they cost about $3 per rod. The banking of Fishing Island meadow, Lower Penns Neck, cost $10 an acre. Another tract brought in, in 1866, cost $15 an acre. The first is about the present average cost. Along Maurice river banking now costs $2 a linear rod, and upwards. These estimates by the acre include the whole expense of cutting drains and water-courses, in addition to the building of banks. For the proper drainage of the meadows, ditches are cut at intervals, varying with the needs of the meadow. These are generally seven feet wide and two feet deep. When they are intended as boundaries, they must be nine feet wide, or no suit for trespass can be maintained. Wide drains with sloping sides are found the best for securing complete drainage. Such meadows need constant attention, and require annually considerable outlay of capital for the necessary repairs of banks and drains, and improvements of the surface. The expense of their maintenance in good order, varies much with the degree of exposure. Generally the cost for repairs ranges from fifty cents to $1 an acre, yearly. The Finn's Point meadow costs on an average $2 an acre per year. Much of the expense is caused by the depredations of the musk-rat which burrows into and through the banks, rendering them peculiarly subject to breaks by high water. The ravages of these animals are met only at an enormous expense every year. To avoid as much as possible injuries from these pests, it is considered advisable to examine the banks at frequent intervals, and to dig out any holes found in them. This work is expensive, as it can only go on at low-water. Some companies employ a man one day each week to examine the banks and note the points needing immediate attention, thereby preventing breaks in the banks, which are so apt to occur where the muskrat has been at work. Another source of danger to the banks is the perforations of the soldier crab or *fidler*. These are very numerous, and their borings into the bank sometimes make it into a complete sieve, through which the water strains upon the meadows. Constant watching is required to prevent their damages. Besides these living enemies the meadow owner also has to contend against breaks from high tides, and from settling of banks. Nearly all banks require occasional additions to the top caused by crumbling of mud, or more frequently by the settling of the whole bank. Where they are built upon firm mud, as is commonly the case along streams, the amount of settling is very little, but where they cross a meadow, or form what is called a *cross-bank*, or run across an old water course, the settling is an item of much labor and expense. Some are known to have sunk down as much as ten feet in the same number of years. The cross-banks are more liable to settle, because of the thinness of firm mud covering the peaty mass beneath. Wherever built upon such peaty substratum, settling is inevitable, and continues until a solid bottom is reached. The settling is generally gradual, but instances are given, in which the bank has gone down at once out of sight. As long as tide-marshes are open, liable to be overflowed at high-water, and so kept soaked full, they remain nearly at the level of high-tide; but after banking and draining they become quite dry, and the spongy mass slowly decays, and is consolidated, thereby causing a sinking of the whole surface. Tillage hastens this subsidence by opening the mass to the action of atmospheric agencies, and by a large annual withdrawal in the form of crops. From these causes a slow and gradual settling is effected. In nearly all banked meadows the difference in heights of the outside *guard* and the enclosed meadow, is very perceptible. The constant silting of fine sediment upon the areas outside the banks, often brings them nearly up to the height of the projecting bank. And after a long series of years of cropping, the meadow settles down to low-water mark, and it becomes unprofitable for further cultivation, on account of imperfect drainage. To remedy this the banks are opened at several points, and the muddy water allowed to enter and deposit its sediment upon the surface. The thickness of this deposit varies exceedingly, some streams depositing much more than others in the same time. Maurice river and Salem creek carry down a large amount of mud, while Alloways creek deposits a mere film on the surface in one season. The meadows are left open to tide water for a period of from five to ten years, according to the rapidity of deposit. A meadow near the city of Salem which has been open to the tide for ten years has now a mud deposit covering it to an average depth of two feet. By this covering of mud the meadows are raised so as to be drained with more ease, and their quality is much improved; the grasses also are much more nutritious. This operation really covers the meadow with a new soil, and one of lasting fertility. Some meadows settle so little that they have been tilled regularly for the last seventy years, and it is said that on some the banks have been in repair for over a century. These are exceptional cases, however. To open the banks require the consent of the owners of three-fourths of the included acres.

Another mode of counteracting the settling, and also of improving the meadow, is to allow the tides to enter during the winter, by opening the sluices. In this way a layer of muddy sediment is deposited all over the surface, which may vary from a mere film to twelve inches in thickness in one winter. The best and most practical meadow managers prefer this winter flooding of their meadows, as an improvement and counteraction of settling. By this mode there is no loss of the crops for five or ten years, which necessarily occurs when the banks are not closed. Others think that flooding is altogether useless ; lime and superphosphates improve them, and there is no need of a a fresh covering of sediment. But as the subsidence is certain wherever there is a peaty substratum of much thickness, flooding must be adopted, or else occasional dressings of marl or upland earth will be needed to keep up the height of surface above low-water mark. The frequent application of soil from the adjacent upland would also be a cheap and valuable amendment to these meadows, which contain an excess of vegetable matter.

These meadows are composed of earthy or vegetable matter, all of which has the common designation of *mud*. *Blue* and *grey* mud is a deposit of clayey substance, and is blue when wet, and grey when dry and weathered. *Black* mud is fine muck, or disintegrated vegetable matter, *Horse-dung* mu d or turf, is the fibrous and peaty matter that constitutes the spongy part of the marsh, and is nothing but a net-work of grass and sedge roots. In most of the meadows the blue mud rests upon the peaty mud. The grey mud is most abundant near the banks of streams. It would seem as if the blue and grey mud deposits of this region are of recent origin; as late as the settlement of the country and clearing of the forests. Streams now hold in suspension a much greater amount of mud than when the country was covered with woods.

The banked meadows of Salem and Cumberland are the very best of grazing lands, and furnish indirectly a vast amount of manure for the uplands. The lowest of them grow herds grass, which is raised for seed. Salem is the great centre of the trade in this product, for our whole country. The average yield is about thirty bushels to the acre, and a common price for it is seventy-five cents a bushel. The stalks though not as good as hay, are valuable for fodder and litter. The care and expense of such lands is but very little, so that the crop may be considered a profitable one. The meadows along Maurice river are found suitable for the growth of timothy and grain and root crops, and enormous crops of these are grown from year to year without any manure. At Finns Point the yield of wheat is from thirty to forty bushels per acre; and of potatoes, from 150 to 200 bushels. The blue and grey mud soils are always good for any crop whatever. The black mud is not reliable for wheat, but Indian corn thrives on it. Lime acts like a charm on meadow everywhere. It is common to use it in dressings of 100 bushels an acre, with good effect; and there is one authentic case of 900 bushels having been used on one-third of an acre, and a large crop of corn being raised on it the same season.

The value of the banked meadows in Salem may average $100 an acre, some being worth $400 or $500, and others considerably less. On the Cohansey and Maurice rivers they are much more valuable than the adjoining upland, ranging in price from $50 to $200 an acre. Before they were banked these marshes were almost worthless. They yielded at the best salt grass or sedge, which may be used as a coarse fodder or for packing. In Lower Alloways creek, Salem county, salt marsh bordering the Delaware is worth from $1 to $5 an acre. About Leesburg, Cumberland county, it sells for from $10 to $20 an acre. The common opinion among meadow men is, that all marsh which can be made to grow herds grass can be profitably banked where the cost of banking does not exceed $15 an acre. In short, all meadow or salt marsh that can be drained by open ditches, may be reclaimed with profit; and if it is two feet above low-water mark that is generally practicable. Where water is quite salt, as is the case near the ocean or mouth of the bay, the meadow will need two or three years to get freshened enough to grow anything except salt grass. Time will, however, in nearly all cases after banking, bring about such a change that herds grass may be raised, if not timothy and the clovers. The great point is to get drainage; the tides can be shut out no matter how high they rise. The question then is, how much is the marsh surface above low water? and if not too low, banking is both practicable and profitable.

The following is a tabular statement, by counties, of the number of acres of tide meadows, fresh and salt, in the State:

Counties.	Number of Acres.
Bergen, ...	11,910
Hudson	12,896

Counties.	Number of Acres.
Essex,	4,282
Union,	4,445
Middlesex,	7,335
Monmouth,	5,958
Ocean,	31,155
Burlington,	25,429
Atlantic,	38,003
Cape May,	58,824
Cumberland,	51,078
Salem,	28,602
Gloucester,	9,958
Camden,	3,652
Mercer,	1,946
Total,	295,474

Of this great extent of marsh, only about 20,000 acres are inclosed by dykes, nearly all of which is along Delaware river and bay. The remaining 270,000 acres are still comparatively unimproved, and worthless for real agricultural purposes.

There are many of the salt marshes which contain too little earthy matter to be very solid, and the tide-water which flows over them is so free of sediment, that none is deposited. When the improvement of these is undertaken they will be found to sink to low-water mark very soon, and if the drainage is continued it can only be done by pumping, or otherwise lifting the water above tide-level, a work which has not been done in this country, but which experience in foreign countries shows to be both practicable and profitable. Holland, which has an area of near 12,000 square miles, has between 6,000 and

8,000 square miles of its surface included within banks or dykes, and it is kept dry enough for cultivation by raising all the water that gets on it from rain, springs and leakage, by pumps, to the height of five, ten, fifteen and in some extreme cases twenty-two feet. The land thus reclaimed is among the most productive in the world. The course of improvement began there just as it is beginning here. At first the marshes were dyked in, and drained by sluices, but as they sank away, it was found necessary to continue the work by draining the water down to a lower level, and then raising it in pumps by the force of wind, and so allowing the settling to go on until the marshes had become solid ground. In addition to the marshes, they have drained in the same way ninety lakes, the last of which, Harlem Lake, covered an area of 45,000 acres, and was, on the average, over twelve feet deep. This immense work required the raising of 1,000,000,000 tons of water, which was done in about four years, at a cost of $3,592,537, or not far from $80 an acre. The first sales of land in it brought $100 an acre, and it is expected that the whole amount of sales will equal the original cost. The annual drainage will require the raising of 54,000,000 tons of water.

On the north and northeast sides of England, there are immense tracts of reclaimed lands. The "Great Bedford Level," includes an area of 680,000 acres of the best land in England, which has been converted by drainage from a dreary waste into a fruitful plain. These lands are too low to be drained by sluices at low-water, and resort is had to pumps, driven formerly by wind-mills, but now chiefly by steam. The drainage is done effectually, and the power required to do it has been carefully calculated.

The rain fall there is twenty-six inches a year, or a little more than two inches a month. This is 7,260 cubic feet on an acre, and can be raised ten feet high in two hours and ten minutes by the power of one horse, or one horse power engine would drain 332 acres. Coleman says "that two steam engines, one of sixty and the other of eighty horse power, are effectual to the draining of 40,000 acres of what is called the *Deeping Fen*. The upper part of these lands, which are thus drained, was peat meadow, the lower part was salt marsh. These lands are now in the highest degree productive, yielding fine crops of wheat, oats, potatoes and swedes, besides furnishing the very best of pasturage and hay lands. There is found to be a difference in the qualities of the grass; the lowest land are fed with sheep, and the highest with cattle. Barley is not cultivated on these lands, but besides the crops above mentioned, mustard, wood and chicory are extensively cultivated. Four crops of wheat in succession have been taken from these lands without manure. As the last crop was less than the former, the land was then laid down to grass. The rent of these lands is $8.55 and $9.00 per acre, but this must be considered as a moderate rent for lands so valuable. By means of these steam engines, the water is kept down to the required level. It is not found necessary to work them at all times, and the power is sufficient for any extraordinary emergency.

"A tract of about 6,000 acres in Nottinghamshire, on the Northern boundary of this county, called *The Carrs*, has been drained in a similar way. The general impression is that the sea once flowed over this territory. Half a century ago this morass was first attempted to be brought into cultivation. At that time it was absolutely a bog, and no horse could be used in ploughing it. The first attempts at draining it were not successful. In 1828 a steam engine of forty horse power was erected at a cost of $30,000 for lifting the water by a wheel. The engine is placed upon the main drain, at about three-quarters of a mile from the river Trent, into which the drainage of these Carrs empties itself; but unfortunately when high tide flowed up that river, there was frequent interruption to the drainage from the water in the river being higher than that in the drain, and it would have flowed in upon the Carrs had not flood gates prevented it. By placing the engine at some distance from the Trent, a reservoir was then formed in the main drain, within that space planked by high banks, aud so by lifting the water into this reservoir to a higher level than the Trent, it is enabled to fall into that river at all times.

"The wheel for lifting the water revolves between two stone walls, in a space about twenty-seven inches wide, through which the whole of the water is driven. The wheel itself is formed of cast metal sides, with wooden paddles between, placed ingeniously at a certain angle, which enables the wheel to lift the water above its own centre; thus a wheel of thirty-three feet diameter creates an artificial drainage equal to more than its radius of sixteen and a half feet. Flood gates are again placed immediately before the wheel, to prevent the water coming back on the wheel ceasing to revolve. Absolute command of the water is now effected, and a provision has been made of incalculable value to the occupiers of these Carrs, by introducing during the summer months, water from the adjoining river Idle, as a supply for the stock. The total cost of two engines for the purpose of this drainage, has been little less than 60,000 dollars, and the annual expenditure of working the engines and cleansing the drains is from sixty-seven to ninety cents an acre."

Our marsh lands are as susceptible of improvement, and as productive when in cultivation, as those of England or Holland—and they are so near the great markets of our country that their improvement is a matter of necessity.

It would undoubtedly cost more labor to drain our marshes by pumping, than it does in England or Holland. Our annual fall of rain in New Jersey averages forty-five inches in depth, with an extreme variation, in different years, of nine or ten inches above or below the average. The annual rain-fall on the east coast of England averages twenty-six inches, and that of Holland thirty inches a year. These figures will enable any one who may desire to compute the amount of work needed to drain an acre, and to estimate its cost.

The New Jersey Land Reclamation Company have purchased and inclosed with a dyke the whole tongue of marsh at the head of Newark Bay between the Passaic and Hackensack rivers, and extending up from the Bay to Saw Mill Creek, covering an area of 6,000 acres. The tide is now effectually shut out, and the water in the ditches stands very nearly down to low water mark. To protect the bank from the ravages of muskrats they put in it a core of thin cast-iron plates, which reach from a foot and a half above the surface to three and a half feet below. They have faced the exposed parts of the bank with stone, are cutting out and opening the ditches and drains, and have already plowed several hundred acres. The energy with which the company is prosecuting this enterprise is in the highest degree commendable, and the successful prosecution and completion of such a work in this place will do more for such improvement than it could anywhere else on the continent. They richly deserve all the advantages their admirably selected location can give them.

The cost of building dikes is likely to be materially lessened by the use of labor-saving machinery. Several banks have been built in Salem county within the last year or two, by the use of a steam dredging machine. It does work at a very moderate price, and in the place where I saw it operating, which was on the bank of Salem creek, in Lower Penns Neck, on Mr. Howard Sinnickson's meadow, it was doing work which could not have been done at all by hand labor, and was building a substantial bank at a cost not greater than that of any other good bank.

The success which has followed the banking of meadows in West Jersey, and the little progress made in such work in East Jersey, has led to the inquiry whether there is any reason for this difference on account of difference in the condition or quality of the marshes on the two sides of the State. To answer this inquiry, Edward A. Bowser, a competent surveyor and observer, was sent to sound, survey, and note the peculiarities of material in the marshes along the Hackensack and Passaic rivers and Newark Bay, and then for the comparison, to do a like work upon the banked meadows along the Delaware and its branches in Salem county. This survey has been completed, and maps of the marshes and meadows have been drawn out by Mr. Bowser. His report to me upon the subject is inserted here, and his maps are appended. I need only say in regard to it that the difficulties encountered in Salem have been much greater than need be expected in the marshes of East Jersey, and that the quality of material for soil does not appear to be any better.

Report of the Tide Marsh on Newark Bay and the Passaic and Hackensack Rivers.

"The accompanying map of the above named marsh represents the *nature* of the surface material and its *depth.* The sounding was done with a slender iron rod, in the months of September and October, when the marsh was tolerably dry. In most places the material was very firm, requiring all the strength of *one* man, and sometimes of *two*, to put the rod down to the bottom. Especially was this the case where the material was blue clay or mud.

On the map the small figures denote the depths of the soundings down to a firm gravel, or sand bottom. The *short, straight, horizontal lines* represent blue clay; the *curved* lines represent peat or muck, which is simply peat or vegetable matter more or less decomposed; a mixture of *straight* and *curved* lines represent blue clay and peat, sometimes mixed, and at other times one overlying the other. The other signs used are explained on the maps.

By referring to the map it will be seen that the marsh between Elizabeth and Newark is mostly blue mud (clay) varying from seven to sixteen feet deep. The bottom is firm gravel. Near the upland, for a long distance, the clay is mixed with peat, and in some places as the Central railroad and near the New Jersey railroad on the northern edge of the marsh, it is all peat. The soundings in the peat and clay vary between three and eight feet.

Between the Passaic and Hackensack rivers, and south of the Morris canal, it is all blue clay and very firm, vary-

Leland Stanford, Jr.
UNIVERSITY

ing between eight and eighteen feet deep. It has a bottom of gravel.

Between the Morris canal and the New Jersey railroad, the map shows that on the Passaic side it is all blue clay, while on the Hackensack river it is blue clay and peat mixed, and up near the railroad and intermediate between the rivers, is the southern edge of an extensive cedar swamp. This blue clay is eighteen feet deep in some places, while the clay and peat mixed is not over twelve feet deep. Near the meeting of the railroad and the Hackensack river it is all *clay* again, and continues on up beyond the Morris and Essex railroad, varying from twelve to upwards of twenty-four feet deep.

North of the New Jersey railroad is a cedar swamp bottom, which extends from the Hackensack river to the upland, on both sides of the Belleville turnpike, and a narrow strip runs north nearly to Berry's creek. In this swamp the stumps in many places are so thick that it is difficult to run a rod down. The soundings vary from three to eight feet, with a sandy bottom. On the edge of this swamp the material is clay and peat mixed, which on the west side extends to the upland, and a little north of the New York and Erie railway. Between this cedar swamp and the Hackensack river it is blue clay, in some places twenty-three feet deep, and extends, with the exception of a little cedar swamp near the upland and the Paterson plank road, up to Hackensack city.

On the east side of the Hackensack river, with the exception of a small area just north of the Paterson plank road, and near the Northern railroad, which is clay and peat mixed, it is all blue clay, very firm, and in some places over twenty-four feet deep.

The marsh bounded by the Morris canal, Hackensack river, Saw Mill creek, and the upland on the west, is dyked in. This takes in most of the cedar swamps. All the rest of this tract of marsh is out to the tide.

Report on the Marsh on the Deleware, in Salem County.

The map of the marsh on the Delaware river and Salem, Alloways, Hope and Stowe creeks, represents the *nature* and *depth* of the surface material, the markings used being the same as those on the map of the Newark marshes.

The map shows that on Salem creek there is much more blue clay than peat. In many places the two are mixed, sometimes there will be a few feet of clay on the surface, while all under it is peat. This is the case on Fisher's Island, which has lately been dyked in. On the surface is blue clay, about four feet deep, after this it is peat, and in many places over thirty-six feet deep. In some places on Salem creek soundings fifty feet in depth failed to strike bottom.

On the Delaware river, north of Salem creek, the clay and peat surfaces are in patches, the latter much exceeding the former in area. The marsh is not so deep as on Salem creek. On the Delaware river, between Elsinboro' Point and Alloways creek, the marsh is mostly peat, and varies from four to sixteen feet deep.

On Alloways creek the material is clay towards the head of the creek, and clay and peat mixed towards the mouth, and varying from eleven to thirty feet deep. On Stowe creek the material is mostly clay and peat mixed, in many places over thirty-seven feet deep. On Hope creek the material is either peat alone or peat mixed with clay, the depth varying between five and twenty feet.

Leland Stanford, Jr.
UNIVERSITY

ri
dy
th
R

Sa
nc
us
m

bl
so
w
Is
is
in
or
st

ar
in
Sa
P
va

he
m
St
in
cr
cl

It is exceedingly difficult to describe localities, on a plain like the marsh, on either of these maps. A reference to the figured depths, and the conventional markings on the maps. will give a clearer idea of their features and substance, than any description in words can possibly convey."

It should be observed that these maps, besides presenting a comparison between the marshes on the Delaware and those on Newark Bay, also furnish important information upon which to base plans for their reclamation, and by showing the material of which they are composed, they show the culture to which they are adapted, and the treatment they need to make them productive for general farm culture. It is an easy matter to make the blue clay deposits into the richest of farm lands as soon as they are well drained, but the peaty soils require much more skill and labor to bring them into the best state of cultivation.

The Wet Lands on the Passaic River and its Branches, the Rockaway and Whippany, above Little Falls.

The country inclosed between the Highland range of mountains, and the curved trap ridges called the First and Second Mountains, being a part of the counties of Somerset, Union, Morris and Essex, is not well drained. The Passaic river, with its branches, flows across the district in crooked channels and with sluggish current, and finally escapes from the basin by falling over a depression in the Second Mountain at Little Falls. The rocky substance of the Mount forms a natural dam, which effectually holds the river in check. So flat is the valley that in freshets the river, which is thus dammed, overflows its banks for more than twenty miles up the stream, and lays thousands of acres of land under water. The current in the river is so feeble that the freshets subside with extreme slowness, and it has frequently been the casé that the entire crop on these flowed lands has been lost, and the accumulation of stagnant water has caused fever and ague to become severe and wide-spread. The damages from spoiled crops, loss of labor, injury to stock, &c., could not have been less than $100,000 in 1867. The occupants of the land in this district have been contending with this difficulty ever since the country was settled; the channels of the streams have been cleared of obstructions, ditches have been dug across the flat grounds, large expenditures of time and money have been made. But it has not been at all alleviated. It is to-day worse than it was fifty years ago.

The water power at Little Falls has been part used for many years. A log on the reef, or a light wooden dam below. which raised the water to near the level of the reef, has sufficed to turn the water off to the mill. During the present year a substantial stone dam has replaced the former wooden one. The owners of the flowed lands have always looked upon this dam with a jealous eye, lest it might in some way increase the trouble the reef itself gave them.

The lack of drainage, and the losses attending it, are apparent; the damage to public health is proved by the mournful experience of many, and the great importance to the State of having this beautiful valley fitted to receive those who would delight to make it their home, if its salubrity were established, is becoming plainer every day. In view of these facts, and desiring to carry our work to prac-

Leland [illegible]

tical ends, I have had levels run and soundings made along the Passaic from Little Falls to Chatham, and up the Rockaway and Whippany to the end of the flat grounds. The results of the survey are put down in the accompanying detailed map, profile and statement of distances, levels, and depths of water, as they were taken by Mr. Bowser. He says "the heights along the *surface* were found by leveling from the benches established by Geo. W. Howell, C. E., in 1868. The position of the *bottom* was determined by sounding in the channels of the rivers, and subtracting the depths from the heights of the surface. In the table the top of Beatty's Dam, at Little Falls, is the datum plane. The heights of the points both along the surface and the bottom of the river, are measured from this plane; those points which are below the level of the dam having a minus (—) sign before the numbers.

By an examination of this table, as well as by an inspection of the profile, it will be seen:

1st. That the bed of the Passaic, from Little Falls up to Horse Neck Bridge, which is $9\frac{65}{100}$ miles, is almost all below the level of the dam. Even in the dryest season the water in this part of the river must stand in many places eight, ten and even twelve feet deep, as there is no way for it to escape, except by evaporation, the bed of the river being so much below the level of the dam.

2nd. That the top of the reef 347 yards above the dam is twenty inches lower than the top of the dam; and the reef alone would dam the water nearly back to Horse Neck Bridge, making it six and eight feet deep in many places.

3rd. That the bar of boulders and earth at Two

Bridges being but two-tenths of a foot below the top of the dam, must be a great obstruction. Even if the dam and the trap reef were both taken away, this bar would dam the water back to Horse Neck Bridge, making it several feet deep. All the work of throwing trees and roots out of the river between Two Bridges and Horse Neck Bridge, while these obstructions remain below, is so much time and labor lost One might as well throw trees and stones out of a mill-pond to make the water run, while there is a good tight dam backing it up.

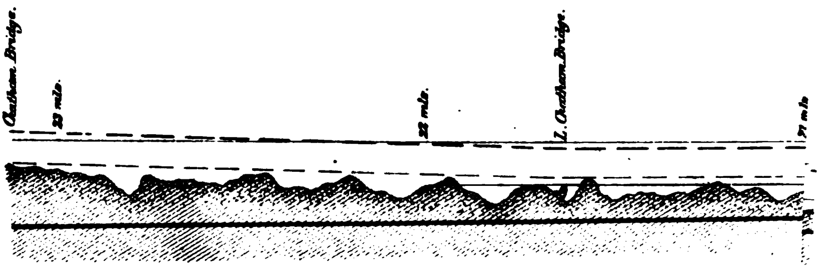
4th. That from the bed of the river at Lower Chatham Bridge to the top of Beatty's Dam, distant twenty-one and three-quarter miles, there is a fall of only $6\frac{3}{10}$ feet, or less than three and-a-half inches per mile. If this bottom slope from this bridge to the top of the dam were uniform, this fall would do very well for a large river like the Mississippi, but for a small stream like the Passaic it would give but a very sluggish current. A fall of three and-a-half inches per mile will give the Mississippi, down towards its mouth, a velocity of over six feet a second, whereas the same fall would not make the Passaic, above Little Falls, run one foot a second.

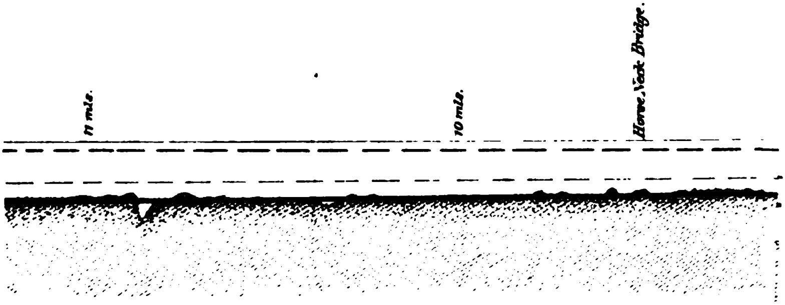
By applying the *New Formula* deduced by Captain Humphrey and Lieutenant Abbott in their investigations on the Mississippi—a formula applicable to the smallest streams and the largest rivers—by applying this formula to the Passaic, we find that a fall of seven and a half inches per mile will give it a velocity between one and a half and two feet a second, even with the present very crooked channel. This fall can be obtained by cutting the dam down seven feet. The trap reef will have to be cut down five and three-tenths feet. A small reef sixteen yards

LIBRARY
Leland Stanford, Jr.
UNIVERSITY

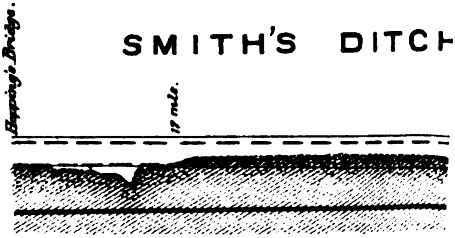
Explanation of lines on the profiles, in the order of their succession.

High water, Jan. 1. 1870.
dto. in 1868.
Low water in 1868.
Grade line 7½ inch.ˢ per mile.
Level of Dam on Little Falls.
Bed of the stream.





SMITH'S DITCH



above the dam will require lowering three and a half feet. From this point, up the river to Chatham, the present river bottom is low enough for the increased slope, with the exception of the bar at Two Bridges, and some insignificant bars at one or two other places; and the scouring action of the water, if the current were increased would probably soon regulate these.

A reference to the profile shows the new or proposed grade with a fall of seven and a half inches per mile—and it is seen that the present bed of the Whippany is above this, so that a small amount of work upon it would give a fall of from one and a half to two feet per mile, which will be sufficient to drain the adjacent lands as deep as is desirable."

There are many curious and interesting facts regarding this stream, and its deep channel, and the influence of obstructions in it—but it is not desirable to draw attention from the main point which is that *for any effective system of drainage for this valley the first step is to remove the obstructions at Little Falls.* Anything short of this will be incomplete, and temporary in its effect.

The advantages to be gained are very great. There are 11.400 acres in the townships of Caldwell, Livingston, Hanover and Chatham which are liable to be damaged by freshets, and there is an area of seventy-five square miles, or nearly 50,000 acres which is more or less affected by this insufficient drainage, and caused to be of questionable salubrity. It would be a small estimate to put an additional value of ten dollars an acre upon this whole valley on account of this improvement, if the land were to be used for farming purposes only, but when it is considered that the land is located within an hour's ride of

New York City, and can be made most desirable for the homes of men doing business in the city, its additional value must be greatly increased. Neither does it follow, if this improvement is carried out that the water-power at Little Falls must be all destroyed; or the benefits which come from such an important manufacturing village be lost. Of the thirty-four feet fall, only the upper fourteen feet are used, and then but half of the water which flows in the stream. Under these circumstances it is surely possible to preserve the valuable mill-privileges of the Falls and yet make this needed improvement.

The valley of the Passaic above Chatham, is also suffering from obstructed drainage, and very great injury is being done both to agriculture and to public health in consequence. The Great Swamp in Morris and Passaic townships is almost a waste from the same cause—and like the others, its improvement would bring a large addition of taxable property to the state, and be of benefit to the community.

The people of Orange county, in New York, have made a vigorous attempt to remove the obstructions in the Wallkill, at the lower end of the Drowned Lands. The successful accomplishment of this work will be very beneficial to a large body of land owners in Sussex county, and it is to be hoped that it will be effectually carried out.

There is a much needed improvement of the same kind to be made in draining the Long Meadow on the Pequest, in Warren county.

The agricultural wealth of the State, as well as the health of our town and suburban districts, is so largely dependent on thorough drainage that it seems appropriate to copy here the conclusions upon this subject which were long since settled by the British Board of Health, and which are now everywhere accepted and are copied in all our books upon drainage.

The following are the chief agricultural advantages of land drainage to individual occupiers or owners:

"1. By removing that excess of moisture which prevents the permeation of the soil by air, and obstructs the free assimilation of nourishing matter by the plants.

"2. By facilitating the absorption of manure by the soil, and so diminishing its loss by surface evaporation and by being washed away during heavy rains.

"3. By preventing the lowering of the temperature and the chilling of the vegetation, diminishing the effect of solar warmth not on the surface merely, but at the depth occupied by the roots of plants.

"4. By removing obstructions to the free working of the land, arising from the surface being at certain times from excess of moisture, too soft to be worked upon, and liable to be poached by cattle.

"5. By preventing injuries to cattle or other stock, corresponding to the effects produced on human beings by marsh miasma, chills, and colds, inducing a general low state of health, and in extreme cases the rot or typhus.

"6. By diminishing damp at the foundations of houses, cattle sheds, and farm steadings, which causes their decay and dilapidation as well as discomfort and disease to inmates and cattle."

"The sanitary interests, also, of a locality urgently demand attention to the drainage of its land; for excess of moisture most powerfully influences the local climate, both as to dryness and temperature, as shown in the report of the Metropolitan Sanitary Commissioners, under the following heads:

"1. Excess of moisture, even on lands not evidently wet, is a cause of fogs and damps.

"2. Dampness serves as the medium of conveyance for any decomposing matter that may be evolved, and adds to the injurious effects of such matter in the air; in other words, the excess of moisture may be said to increase or aggravate atmospheric impurity.

"3. The evaporation of the surplus moisture lowers temperature, produces chills, and creates or aggravates the sudden and injurious changes or fluctuations of temperature, by which health is injured.

"NOTE.—A farmer being asked the effect on temperature of some new drainage works, replied that all he knew was, that before the drainage he could never go out at night without a great-coat, and that now he could, so that he considered it made the difference of a great-coat to him."

The outlet for drainage water is a most essential part of any system of works, and being generally outside the lands to be drained, is a matter of difficult adjustment, in apportioning its expense. The difficulties, however, should not hinder their being made, for, quoting again from the same authority: "Whatever amount of money may be spent for relief by drainage, or however skillfully drainage works may be constructed, the money and the labor will be thrown away, unless the natural outfall be kept clear, or unless an appropriate artificial outfall be provided and kept open."

I would respectfully suggest to this Board that their influence could be usefully exerted in procuring such legislation as would make these improvements effectually, and without being burdensome.

III. ON THE SOILS OF THE STATE, &C.

A beginning has been made upon this subject. A large collection of soils from different parts of the State has already been selected. It is, however, only the beginning of what is needed. By continuing to collect, analyse, and describe soils, we shall finally get together material which will make a classification of our soils possible, and enable us to present principles which must influence the practice of tillage. The soils have a general resemblance in composition, to the rocks which underlie them, and as the rocks extend in belts, across the State from northeast to southwest, the various classes of soils must also lie in the same way. And if a whole belt of soil has the same general character and composition, it necessarily follows that all parts of it are adapted to the same management, and that the same principles of tillage and fertilization should be used throughout the whole. When general principles like these can be established and brought to the knowledge of the great body of farmers, then their united efforts will be intelligently directed, and the methods of a sound practice regulated and put in operation. There has heretofore-been little profit derived from the analysis of soils, but it does not follow that it must be so in the future. There has been a lack of scientific knowledge, to rightly interpret the results of analysis, but this will be met when the attention of whole communities is drawn to the same points.

An application of these statements may be seen in the soils of the valleys in which *magnesian limestone* is the underlying rock. Soils and subsoils to the number of twenty specimens have been selected from various parts of these valleys in Sussex and Warren, and in Pennsylvania from the New Jersey boundary southwest to Lebanon. The following table gives in the first column the average of ten soils, and in the second column the average of ten subsoils.

Analyses.

Silica,	67.88	65.31
Per-oxide of iron,	4.57	8.11
Alumina,	12.88	13.10
Oxide of Manganese,	.44	.37
Lime,	.96	.59
Magnesia.	1.47	1.34
Potash,	2.90	3.87
Soda,	.43	.69
Phosphoric Acid,	.78	.80
Sulphuric Acid,	.03	.04
Organic Matter,	6.61	3.72
Water,	1.61	1.70
	100.56	99.64

These soils have been noted for their fertility, and have been cultivated ever since the first settlement of the country. They are specially adapted to the growth of wheat, and have always yielded good crops even under the worst of management. The analysis shows that they contain an abundance of all the essential elements of fertile soils ; the phosphoric acid, potash, lime, magnesia, and sulphuric acid. The practice of farmers is to enrich these soils by the addition of lime, and by raising clover.

It is not thought profitable to keep any stock upon it except sufficient teams to do the work. Plans to increase the supplies of barn-yard manure, like those pursued in less favored soils, are not thought necessary. Lime causes the mineral ingredients to become soluble, and clover supplies the elements of ammonia. With analyses like these, the intelligent farmer is prepared to lay out his plans for farm management. He knows that he need not buy manure; his attention must be directed to the best tillage and cropping to bring out what is already in the soil.

IV. IRON ORES.

The mining of magnetic iron ore is carried on to about the same extent as in former years, and there is a reasonable prospect that the rich mines now worked will continue to meet the large drafts made upon them for many years to come. The demand for ores is large, and the stimulus to renewed efforts after new mines is great. The veins which were discovered two or three years ago, near Chester, Morris county, are still being worked, and further explorations made, with encouraging results.

The annual supply of magnetic iron ore from the mines could be largely increased, if there were some cheap and easy mode of removing sulphur from the ores. There are many veins and parts of veins of ore which contain a small percentage of sulphur, and for this reason are considered worthless. The common method of roasting sulphurous ores drives off a very little sulphur, but not enough to make the very large quantity of ore now in rejected mines suitable for the forge or furnace. Mr. A. S. Hewitt's Exposition Report *On the Production of Iron and Steel* states that "In the preparation of ore for the blast furnace, Sweden exhibits the model of a roasting furnace invented by Mr. E. Westman, and which was adopted, in the first place, at Dannemora works, and since generally introduced at the other iron works in Sweden. It consists of a vertical furnace, which is heated by a portion of the gas drawn from the blast furnaces themselves, and introduced at the bottom of the roasting furnace through suitable flues, by the aid of natural draught. The temperature in the furnace is carried to such a degree as to soften the ore, and drive off the sulphuric acid arising from the oxidation of a portion of the sulphur, disengaged, by a distillation of a lower temperature, from the pyrites which may be mixed with the ore; a portion, moreover, of the sulphur is oxidized by the oxygen of the ore. Ore thus roasted, however dense when charged into the roasting furnace, is discharged at the bottom quite porous, like a sponge, and almost entirely free from sulphur, if it do not contain more than four per cent. in its natural state. With ore so roasted, and which presents an entirely different appearance from ore prepared in a common kiln, the statement is not surprising that the blast furnace runs with far greater regularity, and with much less consumption of fuel. The introduction of this roasting furnance will be of great value when magnetic ores are smelted with charcoal. It is highly probable that even in furnaces fed by mineral coal, it will bring into economic use a great variety of ore now rejected on account of its sulphur. So important did this furnace appear, that the writer at once engaged a Swedish engineer to proceed to America, and erect a furnace at Ringwood, in New Jersey. The furnace was built and tried, and its performance is more than equal to the promise. It can be examined by the public at any time.

"Besides economizing coal, the Westman furnace, in connection with other improvements resulting from a more accurate knowledge of the theory of the blast furnace, and a careful study of its operation, has greatly increased the weekly product of the charcoal furnaces in Sweden. The general dimensions of the blast furnaces are from eight to nine feet across the boshes, and from forty to fifty feet in height. The average product of these furnaces, driven with a blast heated to 150° or 200° centigrade, is about seventy-five tons per week, which is nearly double the product made a few years since, and now made in the United States from the same class of magnetic ores, which must by carefully distinguished from the brown hematites of Connecticut and the per-oxides of Lake Superior. The charging of the furnace, in particular, is most carefully attended to ; absolute uniformity in the sizes of the pieces of ore is insisted upon, and the charge is distributed over the furnace by a shovel, in which it is first weighed, and then run on a suspended railway to the tunnel head of the furnace, which is never closed. The most intelligent engineers expressed the opinion that the furnaces would give better results if made larger ; but as they are, 100 pounds of cast iron are produced with ninety pounds of charcoal, which is as near as possible at the rate of 112 bushels to the ton."

The introduction of improvements like these, in our iron works, would bring into use thousands of tons of ore that are now considered worthless. It would also increase the manufacture of charcoal iron, which is so necessary for the production of the best qualities of steel. The charcoal blast furnaces now in common use require 200 bushels of charcoal for each ton of iron made from magnetic ore.

Hematite ores have been much sought after in our State, for the purpose of mixing with the richer magnetic ores, mixed ores working much more freely in the blast furnace than the magnetic ores alone. A large amount of these ores is taken from various localities in the valleys where magnesian limestone is found, for the Pennsylvania blast furnaces. This limestone occurs in great abundance in New Jersey. All the limestone valleys southeast of the Blue mountain, in Sussex and Warren counties, are underlaid by this variety of rock. Heretofore very little hematite has been found in the State. The Edsall and Pochuck mines, near Hamburg, have been the most productive, and some small workings have been carried on at various places along the Musconetcong and Pohatcong creeks. In the summer of 1868 a deposit of hematite was found on the farm of Thomas Shields, near Beattystown, Warren county. Some of the ore was taken out, tried, and found to be of good quality. During the present season about eight hundred tons of the ore have been sent to market; trial pits have been sunk over an area of several acres, ore was found in all of them, and a steam engine and appliances for raising and washing the ore have been put up on the ground. The workings show a large body of good ore, and there is no question that this mine will yield an abundant supply for many years to come.

The success which has attended this enterprise has encouraged others in these valleys to search for similar ore, and there is a reasonable prospect of its being found, in many places. The search for this ore should be limited to the limestone valleys. It is not magnetic and the compass cannot be used in searching for it. Its surface indications are found in little fragments of the ore scattered on and through the soil, and in an occasional boulder of the ore. The *final proof* of ore being in any place, is, of course, by digging down through the earth until the ore, or solid rock is found. No blasting of rock is needed. Leslie, in his Iron Manufacturers' Guide; p. 570, says: "Among the circumstances which usually indicate an abundance of the limestone ore beneath the soil, it should be mentioned that one of the most essential is a considerable thickness in the deposit of ferruginous loam, clay, or other earthy matter, resting on the strata. This will, of course, be marked by a corresponding evenness of the surface; for when the beds of limestone are naked of soil in many places the covering of earth, which must contain the ore, can nowhere be deep. Another very necessary condition is, that the earth overlying the rocks should have a large amount of oxide of iron diffused in it. This will show itself by a characteristic bright yellow or clear brown color. It must be observed, however, that the existence of a large quantity of oxide of iron in the deeper part of the soil will very frequently not be perceptible in the color of the surface of the ground—the ore being confined to the lower portions of the mass—so that much good ore-ground is often neglected from want of preseverance in digging."

The search for ores of this kind must necessarily be the work of individual enterprise, but the laboratory of the survey is open for the testing and examination of samples for their benefit, and the members of the survey are ready to give any information they may be able, facilitate the search. Those wishing specimens examined are invited to send them to the office of the Geological Survey at New Brunswick; with as full an account as possible of them and their location.

V. FIRE AND POTTERS' CLAYS.

The rich deposits of Fire Clay at Woodbridge, South Amboy and Trenton, are gradually growing in reputation. They are purer and richer than the foreign clays, yet they have been sold at less than a quarter of the price which those bring. They stand fire better than any imported clays, yet fire clays and fire bricks are brought in and sold at prices far above those asked for our own. There are differences in the modes of working different clays, and it is probably owing to the want of skill in managing ours that has kept them from being estimated at their true value. Heretofore all the clay used in making the melting pots for glass-houses, was brought, either from Europe, or from the vicinity of St. Louis, in Missouri. Nearly two years ago, at the request of Wm. B. Dixon, of Woodbridge, we called the attention of several glass manufacturers to the excellent qualities of these clays, urging that they would answer for the glass-house pots and furnaces, when properly worked, and that a great saving could be effected by using them. A letter has lately been received from Whitall, Tatum & Co., of the Phœnix Glass Works at Millville, in which they say they have been using Mr. Dixon's Woodbridge clay, more or less, for about two years, "in furnace work and in pots for making glass. It appears to us, after this trial, fully equal to Missouri or German clay, and we think this discovery will lead to sales of $50,000 a year of this clay, instead of importations from Germany or England, or freighting from Missouri."

This result is a source of great satisfaction to me, for these fine clays have heretofore been wasted on objects which could just as well have been made from inferior clays, and the most accessible localities were being exhausted before the rare qualities of the material were at all understood. It is to be hoped that our manufacturers will soon bring the requisite skill and intelligence to bear in turning these clays to the best account.

Clay suitable for porcelain, fine and common pottery, paper facing, alum, fire brick, glass-pots, crucibles, stone ware, sewer pipes, &c., can be found in any quantity; and the poorer clay makes the strongest brick and drain pipe that come into market. The belt of country in which these materials is deposited, is admirably located for a great business, and the potteries, fire brick factories, &c., at Trenton, Woodbridge and Amboy show only a fraction of what this business will be in a few years.

J C Smock

ANNUAL REPORT

OF THE

STATE GEOLOGIST

OF

NEW JERSEY,

FOR THE YEAR 1870.

NEW BRUNSWICK:
NEWARK DAILY ADVERTISER PRINT.
1871.

Cat

ANNUAL REPORT

OF THE

STATE GEOLOGIST

OF

NEW JERSEY,

FOR THE YEAR 1870.

NEW BRUNSWICK:
NEWARK DAILY ADVERTISER PRINT.
1871.

GEOLOGICAL SURVEY OF NEW JERSEY.

BOARD OF MANAGERS.

His Excellency Theodore F. Randolph, Governor, and *ex-officio* President of the Board.

Hon. Andrew K. Hay, Winslow, Charles E. Elmer, Esq., Bridgeton,	*First Cong. Dist.*
Hon. William Parry, Cinnaminson, Hon. Henry S. Little, Matavan,	*Second Cong. Dist.*
Selden T. Scranton, Esq., Oxford, Henry Aitkin, Esq., Elizabeth,	*Third Cong. Dist.*
Hon. Andrew B. Cobb, Parsippany, Abram S. Hewitt, Esq., Ringwood,	*Fourth Cong. Dist.*
William M. Force, Esq., Newark, Thomas T. Kinney, Esq., Newark,	*Fifth Cong. Dist.*

STATE GEOLOGIST.

GEO. H. COOK, New Brunswick.

To His Excellency Theodore F. Randolph Governor of the State of New Jersey, and ex-officio President of the Board of Managers of the State Geological Survey.

Dear Sir:—I have the honor herewith to submit my annual report, on the Geological Survey of the State, for the year 1870.

With high respect,

Your obedient servant,

GEO. H. COOK,

State Geologist.

Rutgers College,
New Brunswick, Dec. 31, 1870.

REPORT.

During the year which has just closed:

Edwin H. Bogardus, the chemist of the Survey, has been fully occupied with the analysis of soils, ores and marls, and other fertilizers. His work has extended through the whole year.

Prof. Edward A. Bowser, Civil Engineer, has surveyed the Passaic River from Millington to Chatham, and the Pequest River through the Great Meadows, and has prepared profiles and maps of them. He was employed only a part of the year.

In accordance with a plan submitted to the Board of Managers and approved by them, I have spent between four and five months of the last year in a visit to the Drained Lands of England and Holland, in examining some of the most noted of the Swedish, German and English Iron Mines, and in studying the condition of Agriculture in the different countries visited.

PUBLICATIONS OF THE SURVEY.

There is a continued inquiry for the results of the Survey as published in the Geology of New Jersey. Copies of the work have been deposited in all the public libraries of the State and in those of the cities and towns adjoining. A list of libraries in which it can be found, was published in last year's Report of the Survey.

Both the book and maps are sold to any who wish to purchase at the mere cost of paper, printing and binding. A descriptive list of the publications and their prices and places of sale will be found in appendix C.

PROGRESS OF THE WORK.

In the last annual report it was stated that the chief operations of the Survey would be directed to putting the results of the work in form for practical use. And that in carrying out this leading idea the investigations and conclusions would be arranged and published under the following general heads:

1. On Fertilizers found in the State, and the means of making them more quickly and generally useful.
2. On the Marshes and Tracts of land subject to protracted Freshets.
3. On the soils of the State, their origin, chemical and physical properties, and distribution, with suggestions for their most productive management.
4. On the Iron and Zinc Ores of New Jersey.
5. Additions to the Scientific and Economic Geology of the State.

Upon each of these topics materials have been collected, and progress has been made in preparing them for publication.

I.

On Fertilizers found in the State, and the Means of making them more quickly and generally useful.

In the last report, Analyses of Marls, from the largest marl diggings in the State were presented and an attempt was made to establish the principles for their valuation. Tables were given to show the prices of the different fertilizing constituents of the marl, with which by a very simple calculation the value of each specimen could be determined. The results obtained in this way were interesting, and, as I think, relatively correct, though of course not entirely convincing to some of the dealers in this very useful substance. But I consider the matter to be of too much public importance to leave it without further inquiry, and have therefore had carefully averaged samples taken from the pits of the several companies which deal in marl, and herewith present the results.

ANALYSES.

	1	2	3	4	5	6	7	8
Phosphoric Acid..	1.47	1.60	1.28	2.46	1.34	3.17	4.67	1.14
Sulphuric Acid...	0.00	0.00	1.37	0.17	0.00	0.25	0.51	0.14
Silicic Acid......	50.85	51.10	51.92	57.35	46.82	59.05	52.70	38.70
Carbonic Acid....	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.13
Potash...........	5.33	6.46	5.36	4.47	5.59	4.72	3.81	3.65
Lime............	1.65	2.13	1.68	3.36	2.02	4.65	5.52	9.07
Magnesia.........	2.95	3.85	3.38	2.99	3.10	2.66	2.70	1.50
Alumina.	6.89	9.15	5.40	5.86	6.48	6.67	8.66	10.20
Oxide of Iron....	21.34	18.20	19.82	15.03	23.98	11.27	15.92	18.63
Water...........	8.40	6.75	8.70	8.20	9.70	7.50	6.40	10.00
	98.88	99.24	98.91	99.89	98.98	99.94	100.89	99.16

1. Marl from the pits of Dickinson Brothers, Woodstown.
2. " " " " West Jersey Marl Co., Barnsboro.
3. " " " " Pemberton Marl Co., Pemberton.
4. " " " " Vincentown Marl Co., Vincentown.
5. " " " " Cream Ridge Marl Co., Hornerstown.
6. " " " " Squankum Marl Co., Farmingdale.
7. " " " " Squankum & Freehold Marl Co., Farmingdale.
8. " " " " at Marlboro, Mon. Co.

To compute the value of these marls the prices of different commercial manures, as given by our best authorities, were presented in full. I here present them again only changing that of Prof. S. W. Johnson, and substituting in its place the prices he gave in his report "On Commercial Fertilizers," made to the Connecticut Board of Agriculture, in June, 1870. I reprint also my reasons for the prices I assume for the potash and phosphoric acid in the marl.

Tables for Calculating the Value of Greensand Marl, and for Comparing it with other Fertilizers.

TABLE I.

Stockhardt's Table of the gold values of the chief elements in fertilizers, copied from Caldwell's Agricultural Chemical Analysis.

Form in which the substance exists in the fertilizer.	*price per lb. in gold.*
Phosphoric Acid, soluble in water as in super-phosphate,	$ .12½
Phosphoric Acid in Peruvian Guano, ...	.10
Phosphoric Acid in steamed bones finely ground, in rape cake, poudrette, etc., ...	.08¼
Phosphoric Acid in Baker guano, ...	.07½
Phosphoric Acid in coarse bone-meal, fresh human urine, etc., ...	.07
Phosphoric Acid in coarse broken bones, fresh human excrements, stable manure, etc., ...	.05¼
Potash as potassic sulphate, ...	.06½
Potash as potassic chloride and in other forms, . .	.05½
Nitrogen easily soluble, or in compounds that are readily decomposed, as in ammonia nitrate, dried blood, meat, urea, etc., ...	.22
Nitrogen in finest bone-meal, poudrette, etc., . . .	.19¼
Nitrogen in coarse bone-meal, rape meal, horn-meal, wood-dust, fresh human urine, ...	.16½
Nitrogen in coarse broken bones, horn shavings, woolen rags, fresh human excrements, stable manure, etc., .	.13¾

TABLE II.

The English valuation of these substances is given in Vol. 20, p. 74, of the *Country Gentleman*, by Dr. Voelcker, Consulting Chemist to the Royal Agricultural Society of England. It is as follows, allowing two cents for each English penny:

1. Nitrogen in the form of ammonia,	16 cts.	per lb.
2. Nitrogen in animal or vegetable substances,	12	“
3. Nitrate of Soda,	4	“
4. Phosphate of Lime, (bone earth),	2	“
or Phosphoric Acid alone,	4	“
5. Soluble Phosphate of Lime, or Bi-Phosphate of Lime,	9	“
6. Salts of Potash,	2½	“
7. Gypsum,	2 cts.	per 10 lb.
8. Lime,	2 “	12 “
9. Carbonate of Lime,	2 “	25 “
10. Magnesia,	2 “	10 “
11. Organic matter, (humus),	2 “	20 “
12. Common Salt,	2 “	10 “

PRICES FROM PROF. S. W. JOHNSON.

Prof. S. W. Johnson, of the Sheffield Scientific School, New Haven, has given a new table of prices for some of the most important manures, in a Report on Commercial Fertilizers, made to the Connecticut Board of Agriculture in June, 1870. It has been deduced from the prices of various chemical fertilizers, after a careful re-examination of the whole subject; and is as follows:

Potash,	7	cents per lb., currency.
Nitrogen,*	30	“ “ “
Soluble Phosphoric Acid,	16¼	“ “ “
Insoluble Phosphoric Acid,	6	“ “ “

The phosphoric acid in the marl is combined mostly with lime, though a little of it is probably combined with oxide of iron. The phosphates of lime and iron are both in very fine powder, or else in soft grains, so that while they cannot be quite as soluble as super-phosphate, they are much more soluble than any bone-dust. Judging from Stockhart's table of prices and qualities of fertilizers, I think the phosphoric acid in our marl should be rated between that in guano, which is 10 cents a pound, and that in steamed bones, which is 8¼ cents, and therefore propose for it in our calculations, 9 *cents as the price per pound.* The potash in the marls is combined with silicic acid, forming silicate of potash, which is not readily soluble in water. Johnson's price, 7 cents a pound, is for soluble potash as it is found in carbonate of potash (pearl-ash,) sulphate of potash, muriate of potash (chloride of potassium,) or crude potash. The potash in the marls, is only dissolved out slowly by the action of water containing carbonic acid, and so becomes available. Until there is some more decided reason for fixing a different price, I will set down its value at 2 cents a pound.

---

*Ammonia is $\frac{14}{17}$ Nitrogen, and according to the above price for Nitrogen, Ammonia should be worth a little under 25 cents a pound.

The value of the several marls given in the above table would then be easily made. Considering the phosphoric acid and potash as the only parts of the marl worth transportation, their values range from $3.50 to $8.50 a ton; and I believe, that in comparison with the prices paid for concentrated manures, they are worth that price to the farmer. The cost must be taken when they are upon the soil, and not, as might be thought, when in store. I am confirmed in my opinion of their value by the testimony of successful farmers, who have used them for twenty years or more; and who assure me, they can better afford to incur an expense from $5 to $8 a ton, than to farm without them or to use any other purchased fertilizers; and also confirmed by my own observations in all parts of New Jersey where marl has been used. It gives lasting fertility to the soil. While all other fertilizers are exhausted and the soils become poor, I have never seen a field which has once been well marled that is now poor. One instance was found where poor and sandy land was marled more than thirty years ago, and has ever since been tilled without manure, and not well managed, which is still in good condition. Occasionally marled fields are seen that do not grow crops as large as they once did, but all their fertility is immediately restored by a dressing of lime; an effect which could not have been produced by the lime on unmarled land.

The principle of computing the value of manures in this way, is a correct one, and is accepted everywhere. The prices depend upon the benefits received from the use of the different fertilizers; those benefits being ascertained by the experiments of different persons continued for a number of years. Of course such prices are not yet very accurately settled, and further experience may materially alter some of them. It is very desirable that the attention of observers should be directed to this subject, and if changes can properly be made in the prices, that they be made, and reasons given therefor. I am in the frequent receipt of inquiries as to the value of marl from different pits. In answer to those inquiries I would refer to the analyses and to these lists of prices; and ask the inquirers to compute the value of the marls from them—and if from trial they find reason to modify the prices, it will be esteemed a favor to have them send their conclusions, with the reasons for them, to the office of the Geological Survey.

Other investigations are in progress upon our natural fertilizers, and the subject will be taken up and discussed at length in a future report.

II.

On Marshes and Tracts of Land subject to Protracted Freshets.

In the last Annual Report a survey and profiles were given of the Passaic, Rockaway and Whippany Rivers, in Morris, Essex and Passaic counties. It comprised that portion of the streams about their junction and extended from thence downwards to Little Falls, and up the Passaic to Lower Chatham Bridge, up the Rockaway to the Parsippany turnpike Bridge, and up the Whippany to the village of that name.

There is a large area of land on the borders of these streams which is subject to long continued overflow; and on which in some seasons the crops are entirely spoiled by the water. The object of these profiles and maps was to show the real condition of the streams and to furnish data upon which to base plans for making them fulfil their proper functions in draining the country through which they find their way. The natural obstruction to the flow of water, in these streams is found in a ledge of rocks at Little Falls. This obstruction has been increased by the erection of a dam just below the reef which is raised a foot and a half higher than the reef itself.

The bed of these rivers is deep for the amount of water to be carried, but the current is very sluggish on account of its slight descent. In fact, for nearly eighteen miles up the Passaic from Little Falls, the bottom of the stream is lower than the dam, so that all the current there is comes from the piling up of the water along the more remote parts of the stream and so making an inclined surface down which the water can make its way by this force from behind, instead of being moved by the ordinary power of gravity.

To prevent the overflow of these streams it is necessary to increase the quickness of their currents, and so to enable them to carry within their banks, all the drainage water of the country.

By the profiles it was shown that the form of the rocky reef at Little Falls was such as to admit of its being lowered five and a half-feet at a very moderate expense; and that any further lowering could only be effected by an enormously increased expense. It was remarkable too, that if the rock were lowered to that amount, a grade line with a descent of seven and a half inches per mile would fit the natural bottom of the stream as well as the rock when thus cut down, and that the slope would be almost uniform from lower Chatham Bridge to the Dam. Only a few and comparatively insignificant bars of boulders, gravel, sand and mud would have to be opened to render the descent regular.

The descent in the Whippany can be made somewhat greater, as it should be on account of its smaller size. The expense attending these improvements is not great, and could very easily be met by the owners of the land to be benefitted.

The dam and the water power originally obtained from the reef itself, present more serious dificulties, and become the causes of the heaviest expenses in carying them out. But an examination of the reasons which call for the improved drainage will show that it must be made, and it should be begun at once.

The damage done by freshets in a single year, has more than once been enough to pay all the reasonable expenses of this improvement. There are 11,400 acres liable to overflow; most of these are in meadow and in favorable seasons yield valuable crops of hay. When this hay is spoiled the owners lose it and the labor they have provided to gather it, so that it is not extravagant to estimate the total loss at $100,000, and some consider it to be much more. And this loss has occurred a number of times and sometimes two years in succession. The occurrence of such freshets, and so much stagnant or sluggish water renders the whole region unhealthy, and fever and ague prevail to a great extent in some years.

The thorough drainage of these valleys would render the whole district more healthy and would greatly increase the productiveness and value of the land. In addition to these great advantages to the residents and land owners, the improvement is of general importance to the State, and it would render one of its most lovely valleys attractive and desirable as a location for the country homes of those who do business in our great cities. It is to be hoped that this important work will be begun soon and carried forward with prudence to completion.

During the past season the Survey has been continued up the Passaic from Chatham to Millington and also up a short branch of the Passaic, called Dead River.

There is a fall of twenty feet in the Passaic within about three miles of Chatham, and there are four mills upon it, each of which has a dam. The upper of these is so high that the water is checked in its current for twelve or more miles up the stream, and the low lands along its borders are laid under water with every large rainfall. The meadows are not so extensive as they are upon the same stream below Chatham, but what there are are rendered almost worthless by the frequent floods.

The greatest injury however, is to the health of the residents and the attendant disrepute of property which would otherwise be amongst the most desirable in the State. For the condition of the stream, location and extent of its obstructions, and the obvious means of overcoming or removing them, a careful survey of the stream has been made by Mr. Bowser and his report and profiles are herewith presented. (See appendix A.)

The great meadows in Warren County, have also been Surveyed during the past season. These meadows occupy almost the whole of one of those beautiful subordinate depressions of the great Kittatinny Valley. They lie upon both sides of the Pequest River, in the townships of Independence and Hope, and extend from Danville in Warren to Tranquillity in the borders of Sussex County, a distance of eight and a half miles in a strait line; and they have for a considerable portion of this distance, a width of one and a half miles. They cover an area of fifty-five hundred acres. The soil in these meadows is a black and peaty earth, full of water, and liable to frequent overflows from the sudden rise of the Pequest. It is too flat and wet to be cultivated, and the greater part of it produces only wild and and sour grass of but little value. A part of it along the stream is swampy and covered with heavy timber.

The right of soil in these meadows is held at a very low price, but if properly drained they would become both valuable and productive, and an ornament to the country, instead of being as they now are, an unnecessary blur upon its surface. The original cause for this flat tract of country is found in two reefs of rock which cross the Pequest near Vienna. Projects for draining and improving these meadows have frequently been discussed, and some of them begun, but nothing has been carried through. It has been questioned whether it would be most effectual to remove the obstructions in the stream and leave it to pursue its present channel, or to make a new cut from the river at the lower end of the meadows in a nearly direct line across the ridge back of Danville Church, and on to join the old bed again about a half mile below. Levels and measurements have been taken on both these lines by Prof. Bowser, and his report and maps are herewith submitted. (See appendix B.)

In regard to all these improvements, it should be observed that their completion will require considerable time, some of them several years, if they are to be done effectually and with a due regard to economy. The first object to be secured is a good and sufficient outlet. The work must in all cases begin at the lowest point; and when that is made free and clear, the next point of obstruction up the stream should be removed or opened, and so on in succession. By this means the current is increased from the first, and made to assist in cutting away the soft bars and other obstructions of recent origin. The depth of water is diminished and the labor and expense of working in it is made lighter. In a few years, by pursuing this course, the work can be done so as to secure full and permanent benefit to the whole district needing drainage, and to the State. Any other plan will be expensive and wasteful, and will need to be gone over again; and in the end the method given in these reports must be carried out.

ON MARSHES AND RECLAIMED LANDS.

In former reports reference has been made to our tide marshes and the importance of reclaiming them. In the report of 1869 there were two maps of marshes—one of that about the head of Newark Bay and the mouths of the Passaic and Hackensack Rivers, and the other of those along Salem Creek and the head of Delaware Bay. In these maps the outlines of the marshes were shown, the character of their soils, whether peat, clay, or sand, and their depth to solid ground. The means which have been used for their improvement in Salem and other Southern counties were described, and the extraordinary fertility of the soil upon them was shown at length. The beginning of work for reclaiming the marsh between the Passaic and Hackensack Rivers, near the head of Newark Bay, was also reported. This latter work is progressing; the tide water appears to be effectually shut out, a large tract of land has been plowed, some portion has been cropped, and the enterprise of bringing it into cultivation bids fair to be a success.

The large extent of marshes and salt meadows in our State still unimproved makes this subject one of much interest to the people. And the amount of work to be done and of capital to be invested renders it very important to have the fullest information in regard to what has already been learned by experience in other countries in reclaiming similar lands. To learn more of such works, I have made a visit to the drained lands of England and Holland, and present the following report upon them.

In England the largest drainage works are in what is called the Fen-country. This is an extensive tract of wet, swampy, and marshy land lying on the east coast, beginning about eighty miles north of London, in the counties of Norfolk, Cambridge, and Lincoln, and near the mouths of the Rivers Ouse, Nene, Witham, and others. There are a number of tracts along the east coast, and some of large extent, but they all have the same character and their management is similar. The drainage of the Fen-county about the Nene and Ouse was first undertaken by the Duke of Bedford, and hence is known as the Bedford Level. It comprises about three hundred thousand acres. Much of this land lies below high water level, and so was liable to the overflow of the tides; but its greatest damage was from floods in the rivers which pursue their crooked and sluggish courses through it. These streams carried the drainage water from as much as five thousand square miles of the higher country, and in heavy rains or in wet seasons they overflowed their banks and laid the whole of this flat country under water. In dry seasons some of the land could be cultivated and summer crops secured, but in wet seasons all crops were destroyed. From the earliest periods of English history, attempts were made to prevent the damaging effects of these overflows, but for a long time with only indifferent success. The leading features of the plan pursued by the Earl and Duke of Bedford in their works between 1630 and 1653 were to convey the upland waters through the level to the sea by means of straightened and embanked rivers, and to prevent the tide from entering and overflowing any portion of the Level. The Level was divided into three parts; the North Level containing 40,000 acres, the Middle Level 140,000 acres, and the South Level 120,000 acres. Each level was defended by high barrier banks.

Another feature in his scheme was to cut large new straight drains within each level to carry the ordinary rainfall to the rivers into which they could be discharged by sluices.

The two great defects of this plan were—first, the omission to provide for the improvement of the natural outlets to sea at Lynn and Wisbeach. It went no further than getting the water out of the Fens into the drains and rivers running through the Level, and gave no attention to the discharge therefrom; whereas its first great work should have been to secure for these drains and rivers the best outlet possible to sea, for without that all internal works, however good, must eventually fail. The second defect was in not making the new drains and cuts of sufficient depth. They did not understand or properly consider the nature of the soil to be excavated. This soil was a deep bed of peaty earth which had been growing and accumulating for centuries, and for drains to be permanently efficient, it was necessary that this bed should be cut quite through to the natural soil on which it rested. This was not done, and the consequence was the peat bottoms of the drains began slowly to rise up towards the surface of the water, and so to impair and finally ruin them. While this was going on, a process of a directly opposite character was going on in the drained lands around. While one was rising the other was subsiding. This soon made it necessary to provide other means for passing the drainage water from the lands into rivers and large drains. Associations of neighboring farmers were formed for more effectually draining small districts, and these associations partially attained their objects by erecting scoop-wheels for lifting the water, and wind-mills to drive them. These were in a measure successful, but not to the degree that was needed. In 1821, after years of opposition, a deep cut was made to shorten the course of the River Ouse near Lynn. At this place the river took a bend almost at right angles to its general course for a length of five and a half miles, forming almost a semi-circle, while the diameter joining its two ends was only two and three-quarter miles across. The substitution of this straight cut for the former long and tortuous one was attended with most remarkable and beneficial results. The Ouse at the upper end of the cut had its low water line reduced seven and one-half feet, and there was a corresponding lowering of the water surface in all the connecting drains. Various internal improvements were carried out at the same time, to secure the full benefit of this lower outlet, and steam was substituted for the irregular and uncertain force of wind.

Since then an Estuary Cut for two miles below Lynn has still further straightened the outlet of the Ouse to the sea, and has caused a depression of the low water mark at Lynn of from three to four feet, and has given a greatly increased efficiency to drainage by sluices. It has also diminished the lift for the water which has to be raised from the ditches into the drains and rivers. The system of works necessary to keep up this drainage has been planned by some of the best English engineers, and the constant attention of several professional engineers is now required to keep the various parts in working order, and to make such new erections or changes as are needed. But it is a marvelous success, and the country which was formerly a worthless marsh is now the most productive land in England.

To Mr. Alfred S. Ruston, of Chatteris, England, I am indebted for many particulars relating to the fens. He went with me to examine various farms, to explain their modes of culture and the system of drainage which is now in operation. He gave me all the particulars I could ask for, in full detail, and I cannot do better than use his own words in presenting them :—

"If fen-lands are to be perfectly and successfully drained, the true principle is first of all to secure the best possible outfall for the discharge of the waters, and then to construct the internal works of corresponding dimensions and depths, giving where practicable a natural drainage, and where not, reducing the pumping power to a minimum; and sooner or later I conceive this will be the principle adopted by all the drainage levels in the kingdom.

"One important and somewhat startling fact in connection with the review of the drainage history of the great level during the last two or three centuries strikes one, and that is, that all the great works which have contributed to drain the land effectually, rescuing it from all risk of winter floods, and making it really valuable, have been made during the present century. At the beginning of the century the lands were little more than summer lands, and men were considered demented who ventured to sow a whole field with wheat. But now the fens are the great corn-producing lands of the kingdom, and have been not inaptly termed 'the granary of England.'

"The subsidences of Fen lands after they become drained is a subject deserving attention. The more we drain the lower our lands become, and we are beginning to enquire what is to be the end of all this. I am informed by Mr. Lawrence, the agent to Mr. Wells, that when Whittlesea Mere was drained, to ascertain accurately what the subsidence was, a Doric column was placed in the ground, on which feet and inches were marked downward from the capital, which was the original surface of the land. That surface is now seven feet below what it was when they began to drain the mere eighteen years ago; and in the middle level on all our old drained lands we find the subsidence is still going on at the rate of an inch per year. We learn this from our drainage engines, which are continually requiring the centres of their water wheels to be lowered, or the ladles to be lengthened or they would soon. lose their dip altogether. The increased facilities of discharge through the improved out falls must continue to be felt until the peaty subsoil shall well nigh disappear. One of Lord Orford's companions on referring to their passage through Salter's Lode Sluice, tells us that the tide rises at that place five or six feet. On the 21st of February of the present year, it rose to twenty-two feet three inches at 11:15 P. M. The effects upon drainage of this altered state of things, and consequently upon subsidence, must be obvious to everyone.

"The Fen rivers and drains so useful and essential for the discharge of the flood waters of winter are scarcely less valuable for the supply of fresh water in the summer. It is not easy to overestimate the immense value of a good and a liberal supply of fresh water for the whole Fen County during the dry summer months, and I need hardly say every effort is made to obtain this. The practice of irrigation has not found much favor in the Fens, and it is questionable whether it would be of any great good where the waters possess so few fertilizing elements. Irrigation appears to depend for its success very much upon the chemical substance contained in the waters. An analysis of the water will pretty correctly indicate what will be the effects of its overflow Cultivation and drainage have gone on hand in hand, each successive improvement in the one, leading to a corresponding improvement in the other. During the early drainage history, most of the low-lying Fen lands were kept in grass, as they could not be profitably brought under cultivation in consequence of their liability to inundations during every recurring flood. Some farmers ventured to sow a few oats on the higher lands, but it was not until May was well in and the winter rain-falls had passed away to sea. By-and-by oats were grown more largely, and wheat was cultivated to some extent.

"Then came the system which prevailed very generally in the Fens for a good number of years, and which was to let the land keep in grass for two or three years, then pare and burn, and sow with coleseed to feed with sheep during the winter months, to be followed by oats, and then wheat; and again sown down with seeds to remain two or three years, often three. This virgin soil, under such management produced coleseed of most extraordinary fattening qualities, and perhaps there has never been any natural food that would compare with it, or that would in so short a time produce so much weight of mutton. It was otherwise with the seeds, for after the first year they contained comparatively little nutritive properties, and their long countinuance on the land made a fine refuge and breeding ground for the wireworms, to which the succeeding crops oft times bore indubitable testimony; and to this day they remain the greatest foe the Fen farmer has, and it is a very unusual year when his oat-crop is not more or less ravaged by them. Probably the greatest improvement next to drainage, and consequent upon it, is the practice of claying fen lands. The value of clay, I believe, was first accidentally discovered by some of it which had been thrown from the ditches having been spread round the outsides of the field, and which produced most marvellous effects upon the growing corn crops.

Our father's were not slow to learn, and were very soon led to adopt a system of claying which still continues, some lands having been gone over three or four times. The plan is this: pits or trenches are made down the fields, from two and a half to three feet wide, and from twelve to sixteen yards apart; two spits of clay are taken therefrom, and spread upon the intervening land, the peat or clunch subsoil being thrown to the bottom of the trench, and when all is finished, the pits are ploughed in, and the land being loose, and easily moved, is soon levelled again. The cost of claying is governed by the depth at which the clay is found from the surface of the land; but improved drainage occasioning a continual subsidence, as I have already observed, is bringing it within easy reach, and thousands of acres can now be done at a cost of thirty shillings per acre, and under; and no money expended on a Fen farm, yields so quick and so bountiful a return. The application of clay to these light soils not only gives solidity, but being possessed of considerable fertilizing properties, greatly enriches them. Happily the Fen lands very largely rest upon a clay bed; but the clay is not of a uniform quality. That which is blue and of a soft buttery nature, contains the most lime, and is the best fertilizer. Some is silty and some stony and hard, and these do little more than solidify. Perhaps the next great improvement consequent upon the drainage of Fen lands is their deep cultivation, to which reference has already been made. To talk of turning over a furrow slice thirty inches in thickness must sound to a clay-land farmer something like a piece of exaggerated nonsense; and may put his credulity to the test, but it is no exaggeration. Deep cultivation on Fen land is generally accomplished by horse power, as the great underground forest offers considerable obstacles to the application of steam. A pair of horses in a common plough go first, and take a furrow four or five inches thick, and are followed by a huge implement made expressly for the purpose, and which is pulled by six, eight or ten horses as the case may be. This plough buries the furrow turned over by the small plough, and brings the subsoil well on to the top, that its vegetable properties, by exposure to the atmosphere, may become speedily decomposed, and made available as food for plants. One object in putting the top furrow down is to get it as far as possible beyond the reach of atmospheric influences, with the idea that under these circumstances the twitch or couch and weed roots will die and decay. It certainly is a very clever and ingenious way of cleaning land, if it can only be done; but my experience and observation lead me to the conclusion that it far oftener fails than succeeds. I think land should be quite clean before it is deep ploughed. There can be no doubt but deep cultivation tends to preserve moisture in the soil in dry seasons, and to facilitate drainage in wet ones. It also unlocks those hidden treasures in which are so many elements of fertility, and consequently increases the producing power of the land. Drainage, clay, and deep tillage, to which should be added super-phosphate of lime and the water-drill, have completely metamorphosed the country, and altogether changed its modes of husbandry; and perhaps there is now no country so utterly defiant of system. Every one sows what he thinks he will, and by proportionately liberal management labors under no apprehension that his soil will become exhausted; nor will it, if he treats it generously and cultivates it wisely. Although there is no uniformity of system in the cultivation of fen lands, there is, however, a five-course-shift which has found favor, and which prevails more largely than any other, and to which several farmers pretty strictly adhere. This is the order of it: mangolds, kohl rabi, coleseed or cabbages, which are gradually growing into favor; oats, wheat, seeds, wheat. The green crops and the oats are sown with artificial manure, the farmyard manure being reserved for the wheat crops. This rotation appears well suited to the fens, and has been pursued with considerable success; but as I have intimated fen farmers break away from the restraints of system to follow their own inclinations. A ride through the fen country at the proper season will show the truth of this. In addition to the crops usually found on a farm will be seen coleseed, turnip seed, linseed, mustard, and cress growing as seed crops, and potatoes and carrots extensively cultivated for the London and other large markets. Turnips are not at all suited to fen soils. They grow of a woody, fibrous quality, coarse and long in the neck, and possessing scarcely any nutriment; they are almost valueless as food for stock, and are consequently not cultivated.

"Kohl rabi and mangolds are much better, but these, like the hay, straw, and other products of fen-lands (coleseed excepted) are very deficient in fattening properties. I have already referred to the water drill and super-phosphate of lime and their value in the successful cultivation of fen-lands. Our fen-soils appear to yield much larger supplies of ammonia than phosphates; hence the free application of phosphatic manures is accompanied by much greater and more palpable results than is the case where ammoniacal manures are used. Probably there is no part of the kingdom where the application of phosphates to the soil has produced such startling results, and especially where they have been applied with the water-drill. The fens have not been especially famed for the breeding of either cattle or sheep, but from very early times they have been noted for their good breed of cart-horses. The decreased average of grass seeds, consequent upon the increased average of corn and other crops, has largely tended to diminish the number of animals bred; but the show of cart-colts, both as regards number and quality, on the first of July of every year, is pretty good evidence that fen-farmers have not altogether lost their long-enjoyed and well-merited reputation.

“ The Great Level generally, even now, under its more perfect drainage and improved cultivation, offers very few tempting residential inducements, and formerly, under other and more unfavorable circumstances, it repelled rather than invited residence. Hence it is not uncommon, in many parts of the fens, to find both farmer and laborer residing in the town or village rather than upon the farm.

“ The value of fen-lands has increased or decreased just as the drainage has been efficient or otherwise. In 1651 Lord Arundel, one of the Earl of Bedford's associates, in draining the Great Level, became so discouraged by the reverses and losses sustained by the adventurers that he sold his share for 3s. 9d. per acre, the same land now being worth probably from £30 to £50 per acre. Many farms in later times have been sold at very little over their present annual rentals, and some at even less. Through the kindness of Mr. Richards, Trimblington, I am able to present the assessments to the poor rates of certain lands in the parish of Doddington, made at different periods, showing the influence which improved drainage has had upon the value of fen lands :—”

	Acres.	Rateable Value.
1736	200	£40 0s. 0d.
1784	200	60 0 0
1822	200	100 0 0
1869	200	238 0 3
1784	60	15 0 0
1833	60	21 0 0
1869	60	68 1 4
1757	20	2 0 0
1784	20	5 0 0
1869	20	26 0 0

The above statement has been written by Mr. Ruston since I enjoyed the benefit of his explanation on the ground, and he has favored me with the printed copy. His residence is in what is called the black-fens, the soil being black with muck and decaying vegetable matter for a depth of from two to ten feet. The clay, of which Mr. Ruston speaks, is the earth under the peat, and is quite calcareous. There are portions of the fens nearer the western border—for example, near Peterboro—and the Whittlesea Mere where the whole substance is black and more like turf. Such cannot be cultivated until they are burned over, so as to get an accumulation of ashes, or else are covered with earth brought from the upland, or from pits sunk through the peat down to the solid ground. Pits are sunk through the turf nine feet deep in some places, to raise the bottom earth to the surface, and the land is dressed with it at a cost of from $12 to $18 an acre. I saw good crops of grain, cabbage, and turnips growing on ground prepared in this way. The fens containing turf are, however, the most expensive and difficult to reclaim, and there are considerable tracts which have not yet been cultivated.

The parts of the fens nearest the sea-shore or on the river banks are the best. The soil contains a large proportion of sand and clay sediments, and is not liable to settle, and it needs no claying. It has been filled up by the deposits from muddy water and the wash from the river floods. It is the very best and most productive of all these reclaimed lands.

The banks which are built to confine the streams and hinder them from overflowing the country on their way to the sea, as well as those along the sea-shore, are of the most substantial kind. They are constructed after the plans of engineers, and built under their directions. Generally they do not differ from the banks of canals or other structures which are required to resist the pressure of water.. From the nature of the fen soil—the layers of peat, sand, and mud in it—great care is necessary in preparing the foundations of the banks. Those which are built now are usually six feet wide on the top, and built with a slope of two base to one rise; and to keep them firm they have a foreshore of from six to fourteen feet, and the middle of the bank is puddled with clay. This puddling is done by digging a trench three feet wide along the middle of the foundation, and sinking it down to the solid bottom. The trench is then carefully puddled with clay quite to the surface, and up as far as the nature of the materials in the bank require, in order to make them watertight. Like all other works of this kind, there have been numerous and expensive failures in the banks from lack of good foundations. In 1862 a most extraordinary accident took place from the undermining of the sluice gates of the main drain of the Middle Level, at its confluence with the River Ouse. This drain has to carry an immense quantity of water. Its bottom is seven feet below low-water mark, and forty-eight feet wide; its sides have a slope of two base to one rise, and spring tides there have a rise of nineteen feet, so that its width at the high-water line is one hundred and fifty-two feet. The sluice gates were like canal lock gates, and in three pairs of thirteen feet each, thus making a clear water way of seventy-eight feet. The water in this drain runs out through the sluices during low water, until it almost comes to low-water mark. From some imperfection in the foundation these sluice gates gave way and the tide-waters were let into the drain. They rushed up and again poured out of the drain with great velocity, and throughout a distance of twenty miles they ebbed and flowed. This state of things continued for several days, when one of the banks of the drain burst and let the water in upon this low but rich and cultivated country, and completely inundated six thousand acres of land. The damage done by the flooding was enormous.

The method resorted to for again stopping the drain is very curious, and may be worth the description. With great pains and at a large expense a solid, strong dam was built across the drain so as to completely shut out the tide, and then sixteen syphons, each three and a half feet in diameter, were laid so as to draw the water out of the drain above the dam, carry it directly over the top, and discharge it into the drain below. The syphons are set in operation by means of a steam engine and air-pump, and they are guarded by valves so that they may not carry water up stream during the flow of the tide. They have now been in operation eight years, and have answered their purpose completely. The water in the drain flows up to the dam with a strong current, runs over it in the syphons, and then, a great river of water, it runs off in a rapid current towards the sea.

Some of the oldest of the banks are still settling, with the long-continued drainage of that country, and every year they have to make repairs, at large expense, of cracked and settled banks.

When the water in the streams is high the drains cannot discharge all the water that falls on the fens into them; and with the continued settling of the soil the sluices come to be more and more incapable of discharging all the water. When the drainage was first completed, wind-mills were used to pump the water from the ditches into the drains; but they were too uncertain in their action. When the water was abundant, and there was no wind, the lands would be overflowed, and now steam engines have almost entirely taken the place of the old wind-mills for driving the pumps. There were formerly as many as seven hundred on the fens between Lincoln and Cambridge—a few are still left, but the place of most of them is taken by about sixty steam engines, which range from ten to eighty horse power.

The water is chiefly raised by scoop-wheels, and not by pumps. These wheels are almost like the paddle wheels of a steamboat, and they are set so as to fit closely, but without touching, between parallel stone walls, and the bottom is curved upwards in front. When the wheel turns it presses the water forward in the narrow passage and upward till it is raised sufficiently to run over into the drain. Such wheels will lift economically to a height equal to one-third their diameter. The height to which the water has to be lifted varies in different localities. From two to ten feet are common cases.

Some very large rotary pumps have recently been erected for the drainage works near Boston, in Lincolnshire, and it is claimed by the ablest engineers that they are cheaper to work, and more efficient than the scoop-wheels.

The amount of water raised is enormous. At one place in the Deeping Fen the engines raised three hundred tons a minute to an average hight of seven feet, and the whole fen of 25,000 acres is drained by two engines of sixty and eighty horse power.

The way of determining the power needed for any drainage is to take the greatest rainfall in any month, make the proper allowance for evaporation, and then calculate the number of tons of cubic feet of water that will remain on the whole number of acres to be drained. Then allow that the engines can be kept at work twenty-five days in a month and twenty hours each day, which is five hundred hours a month. Then provide an engine and pump which are capable of doing the work, and the plan is completed.

The machinery and power necessary to drain these lands is now well understood, and is put in operation. The water is kept in the ditches at a level which is from two to three feet below the surface of the ground, varying somewhat with the crops that are to be grown. It is found that the presence of the water within that distance from the surface is favorable for the growing crop, and a security against drouth. The last summer was one of unexampled dryness, and the fen farmers found it was very useful to them to have water in the ditches, and great care was taken not to let the water out below a certain level; but on the contrary to dam it back so as to hold it up to the proper height.

Mr. Ruston informed me that a portion of the fen near Chatteris, in which he is interested, contains 10,000 acres, besides 2,000 acres of upland, and it is drained by an eighty-horse engine at a cost of six pence an acre per year. This is the cost for the year, but it is not by any means the annual tax, as additional to the expenses of the year, there are large debts which have been contracted and must be paid; also, parliamentary and other expenses. The tax in 1870 was 1s. 9d. an acre on most of the land, and 10½d. on the rest. The heaviest taxes that can be imposed upon these lands are 3s. 6d. and 1s. 9d. an acre. The taxes in some other parts of the fens are a little higher, being from 4s. to 6s. an acre.

The first cost of these improvements has been enormous—95,000 acres out of 300,000 were given to the first Earl of Bedford for making the drains and connected works—and there are many districts in this Great Level where farmers have combined to make additional improvements at their own costs. It is said that there are more than a hundred acts of parliament relating to the fen drainage. The parliamentary expenses are very large, as every bill is strongly opposed and must be fought through. The Middle Level has a debt of £500,000, and arrangements have to be made for paying it off within twenty years of the time it was contracted. The expense of the syphons in the Middle Level drain were £62,000. Other sums of money equally large are spoken of in connection with different parts of the fens; but it is found by experience that they are small when compared with the value of the land or its extraordinary fertility. It bears all these expenses, and continues to increase in its power of yielding productive crops and supplying food to the rest of the kingdom.

THE NETHERLANDS have long been noted for the great extent of land liable to overflow. The country itself is very flat and low and has no ranges of hills to break the uniformity of its surface. It is open to the North Sea along its north and west borders, and on the south is crossed by the Rhine, which brings down an immense volume of water from the hilly and mountainous parts of Western Germany. In North and South Holland there is a border of sand hills, dunes, or, as we should call them, beaches, along the sea, but the more southern provinces have no such protection, and are exposed to the direct action of the waves. In both, however, the country is liable to be overrun by the sea, the only difference being that the water naturally runs off quickly in the southern provinces, while in the northern the dunes hold it back and so favor the growth of turf and the accumulation of muck. Along the Rhine the country is equally exposed, and when great floods occur in that river and the water comes down to the flat country where its current is checked, it overflows its banks, covering the whole country and causing frightful damage to life and property.

In dry seasons some of the ground could be cultivated or pastured, and so support human life. But the dangers to which they were exposed obliged them to maintain a constant struggle with the floods,—and the history of the country is full of accounts of the making of dikes and their failures. At first, the dikes were made of reeds and grass, later, of logs and beams of wood; more recently of earth, and in exposed parts they are faced with stone, brush, straw and grass. The kingdom has an area of about 12,000 square miles, and full one-half of it is so low as to need protection from the water. Heavy banks or dikes are built along the shore of the sea and the borders of the rivers to keep out these floods.

The leakage water and the rain-fall were drawn off from the higher portions of this land by means of tide-sluices which opened so as to allow the water to run out at low tide, and closed, to hinder any from running in at high-water. The larger portion, however, was too low for this mode of drainage, and rain and leakage waters had to be raised by pumps. In some localities the water has to be raised only one or two feet; in others ten, fifteen, twenty, and in a few places even twenty-two feet, before it will run off into the rivers or sea.

The magnitude and importance of these works can hardly be estimated. The oversight and management of them is entrusted to one department of the Government, the Waterstaat, and there is a special corps of engineers devoted to that branch of their profession.

The chief works of drainage have grown with the exigencies of the case. At first very slight dikes would be required, but as the land was drained and occupied it settled, making it necessary to increase the height and size of the dikes, and also carrying the surface of the water in the ditches lower and lower until the sluices were no longer able to drain it off, and the erection of pumps and windmills to drive them then became a necessity. This mode of driving pumps has been the favorite one in the Netherlands for various reasons. The country is flat and the winds that sweep over it are strong and steady, furnishing an abundance of power at a cheap rate. Steam engines which are their chief competitors, require fuel, which is expensive, and in times of disturbance might not be easily obtained.

In wet seasons, or in still weather when the mills could not work, the land suffered much. This led to the growing of such crops as are least injured by water—and hence pastures and meadows are much more common than fields of grain or other cultivated crops. For the best of pasture and meadow the water in the ditches only needs to be kept eighteen inches below the surface of the soil—while for growing grain or other cultivated crops to the best advantage, the water must be kept three feet below the surface. Though windmills, then, would furnish the cheapest power, there were seasons when the country suffered greatly for want of an agent more under control. Especially was this the case where lands were entirely under water and needed to be pumped dry before any improvement could begin. It is said that ninety lakes have been drained in Holland, and while some of the smaller could be pumped dry by windmills, the larger ones needed the steady power of steam. One of the greatest engineering works of the age is the draining of Haarlem Lake, a large body of water which lay but a short distance south-west of Amsterdam.

"* The origin and history of this great enterprise is as follows: In the year 1539, the North Sea, long restrained by artificial dams and dikes, as well as by some natural ridges of sand, suddenly burst its barriers, and brought horror and desolation into the fertile flats of North Holland. Twenty-six thousand acres of rich pasture land, with meadows, cattle and gardens, were covered by the waves, and the village of Nieuwenkirk was submerged and all its inhabitants lost, in the tremendous calamity. The inundation resulted at first in the formation of four lakes, but the barriers of soft alluvial soil which separated them were gradually destroyed, and the four lakes became merged into one. The degradation of the shores also continued, until, at the commencement of the eighteenth century, the waters covered an area of 45,000 acres, with an average depth of thirteen feet below low water in the Zuyder Zee. This lake constituted what has since been known as the Haarlem Meer or Sea. The people of Holland saw with much alarm, the rapid extension of its boundaries, and at an expense of about $160,000, succeeded in partially arresting its progress; an expense of about $20,000 per year was moreover entailed for the preservation and repair of the works of defence. More than two centuries elapsed after the time of the first inundation before any one began to dream of recovering this vast tract of country, and then, for a long period, all plans proposed were deemed impracticable. At length, on the 9th of November, 1836, a furious hurricane from the west drove the waters of the lake upon the city of Amsterdam, and drowned upwards of 10,000 acres of low land in the neighborhood. On the 25th of December following, another hurricane, from the east, drove the waters in an opposite direction upon the city of Leyden, the lower parts of which were submerged forty-eight hours, and 19,000 acres of land were inundated. The enormous loss occasioned by these two storms induced the government to determine on the drainage of the lake, and a credit of $3,200,000 was voted by the States General. In May, 1840, a commission was appointed to superintend the work.

---

*Ann. Sci. Disc. 1853; p. 31.

"The first operation was to cut a canal round the lake, to isolate it from the neighboring waters, and to afford the means of navigation to the enormous traffic which previously passed over the lake amounting to 700,000 tons per annum. This canal was thirty-seven miles long, one hundred and thirty feet wide on the west and one hundred and fifteen feet on the east side of the lake, with a depth of nine feet of water. On the side next to the lake, the mouths of all water courses entering it, were closed by earthen dams, having an aggregate length of three thousand yards, made in ten feet depth of water. Other great works were executed by enlarging the sluices at various points, and erecting powerful steam engines to assist in discharging the water from the canal during the time of high water. The water of the lake has no natural outlet, being below the lowest practicable point of sluicage. The area of water enclosed by the canal was rather more than seventy square miles, and the quantity to be lifted by mechanical means, including rain water, springs, leakage, &c., during the time of drainage, was estimated at 1,000,000,000 tons. In determining the motive power to be employed, two points were to be kept in view: first, the cost of draining the lake; second, the cost of annual drainage; for, when once the work was accomplished, the site of the lake could only be kept dry by mechanical power. With the exception of a few steam engines, the wind had hitherto been the motive power employed to work the hydraulic machines used in the Netherlands to keep the country dry. And the power of 12,000 windmills, having an average aggregate power of 60,000 horses, is required to prevent two-thirds of the kingdom from returning to the state of morass and lake, from which the indomitable energy and perseverance of the Dutch people have rescued what is now the most fertile country in Europe.

"The Haarlem Meer Commissioners were convinced that the old means must be laid aside, and new ones adopted to suit the magnitude and peculiarities of their work. They accordingly determined to erect three gigantic steam engines of a peculiar construction, which was accordingly done, and the whole put in operation in 1848. These engines consume but two and a half pounds of coal per hour, for each horse power, and are capable of raising one hundred and twelve tons of water ten feet high at each stroke, or of discharging 1,000,000 tons in twenty-five and a half hours.

"A short description of one of these engines may prove interesting. It has two steam cylinders, one of eighty-four inches diameter, placed within another of one hundred and forty-four inches diameter; both are fitted with pistons; the outer piston is of course annular, and the two pistons are united to a great cross-head, or cap, which is furnished with a guide-rod, or spindle; both pistons and cross-head are fitted with iron plates, and together, with parts of the engine attached, have an effective weight of nearly ninety tons. The engine house is a circular tower, on the walls of which are arranged eleven large cast-iron balance-beams, which radiate from the centre of the engine. Their inner ends, furnished with rollers, are brought under the circular body of the great cap, and their outer ends are connected to the pistons of eleven pumps of sixty-three inches diameter each; the stroke of both ends is ten feet, and the discharge from the pumps sixty-six cubic metres or tons of water per stroke.

"The action of the engine is very simple; it is on the high-pressure-expansive-condensing principle. The steam is admitted first beneath the small piston; and the dead weight of ninety tons is lifted, carrying with it the inner end of the pump balances, and of course allowing the pistons to descend in the pumps.

"The equilibrium valve then opens, and the steam in the cylinders passes round to the upper surface of the small and annular pistons; puts the former in a state of equilibrium, and presses with two-thirds of its force upon the annular piston, beneath which a vacuum is always maintained; thus the down-stroke of the engine, and the elevation of the pump pistons and water, is produced by the joint action of the descending dead weight in the cap and pistons, and the pressure of steam on the annular piston. The engine has two air pumps of forty inches diameter, and five feet stroke each. The water is lifted by the pumps into the canal, from which it passes off towards the sea sluices. The total weight of iron employed for the engine, pumps, &c., is six hundred and forty tons. The cost of the machinery and buildings was $175,000."

"*The last openings in the surrounding dike were closed in

---

*From Buysing's Waterbouwkunde.

the beginning of June, 1848, and one engine was started on the 7th of that month. The water in the lake then stood at twenty-five and a half inches below the Amsterdam Level.* On the 11th it had been lowered to thirty-two and a half inches, and after thirty days' operation the water stood at three feet below. In October the level was reduced to three feet one and a half inches, which left the banks exposed to all kinds of danger from the approaching stormy season. The two other engines were set at work February 26, 1849. In one years' time they brought down the surface of the water to six and a half feet below A. P. By this time some difficulty was experienced in bringing the water to the engines on account of its shallowness near the shores. Two of the engines stood almost exactly at the opposite ends of the lake, and a conducting drain was dug between them, which divided the lake into two nearly equal parts. A cross drain was also dug, cutting the first at right angles. They were cut to the full breadth of sixty-five and a half to eighty-two feet, but only to the depth of ten feet, and later to that of thirteen feet, equaling the average depth of the Mere, which was,. for the time, satisfactory. Afterwards these ditches had to be lowered to nineteen and three-quarters feet, and in 1857 they were deepened to twenty-one and one-third feet. The last portions of water were troublesome to drain off to the pumps, and the engines could only work intermittently. In June, 1852, the water of the Mere finally disappeared, and in July the ground became quite dry. The work thus lasted four years and one month, but as only one engine worked for the first part of the time, it is considered that the whole is equivalent to three years and seven months' work of the three engines.

---

*The datum plane to which all levels are referred in Holland is on a level with an established point of reference in Amsterdam. This mark is usually spoken of as A. P. (*Amsterdam Peil.*)

"The first engine made an average of from eight to nine strokes a minute, and the other two an average of from six to seven; and in the whole time nearly 14,000,000 strokes each. The whole amount of water that was raised was 832,000,000 tons."

"The total expense of the undertaking, from 1839 to 1855 inclusive, has been $3,600,000. The land was at first valued at thirty-three dollars an acre. Subsequent examination proved that the soil laid bare by the draining operations was of far greater value than was originally supposed. Thus, in 1853, 1,936 acres brought $230,000, or $118 per acre; and though subsequent sales have not realized such large prices, yet the land commanded a much higher price than the first valuation. 'This result,' says M. D'Endegrest, 'surpassed all expectation, inasmuch as the grand object of the drainage was rather to put an end to the encroachments of the lake than to make a lucrative speculation of it.' It is stated that a great number of farms are springing up on all sides, and that the cultivation of the rich land is affording employment to many hundreds of laborers. The total amount of land available for agriculture is estimated at 44,400 acres; and by proper care and supervision it is confidently expected that no water overflows will take place.

"The value of the land recovered by Holland from the Lake of Haarlem is increasing at a rate which insures payment of all the outlay for the drainage in a comparatively short time.

"No ill consequences were experienced from intermittent fevers, as was dreaded when the surface was first laid bare, and the numbers of dead fish had no other effect than to fertilize the soil."

A visit to this dry lake in 1870 proved very interesting. It is traversed by excellent roads, the ditches are kept clear, and the water is low in them, about three feet below the surface. Farm houses are located everywhere about the bottom of the lake, and trees, shrubs, and all the appendages which belong to pleasant and prosperous farmers' houses, are found here just as though they were not beneath the level of the sea. For some years after the lake was drained the lowest parts continued wet and unpromising, and the land was held at a low price, but by reducing the drainage level still further, this portion has become quite as dry as any part of it, and the soil being heavier it is now more valuable than any of the rest. With the exception of some strips along the edge, from which the peat has still to be cut or burnt off, every acre is now productive. I saw here one of those remarkable Dutch dairies; the cow stables, cheese house, and dairyman's dwelling all under the same roof, and all perfect models of neatness.

The yearly expense of keeping this Haarlem Meer *polder** dry is not great. My informant, who was a land owner in it, told me that his taxes there were ten florins per hectare, and that they were seven florins per hectare in one of the small lakes which he had drained. These prices are equivalent to $1.62 and $1.13 an acre, which is not high for the work done and the valuable service rendered in always having a full supply of water only three feet below the surface.

The success of this enterprise has led to the undertaking of several others of the same kind, and to the projection of still more. The Great Ship Canal now in course of construction between Amsterdam and the North Sea passes for twelve miles of its length through the Y, a large body of water which is about four feet deep. The canal is built by dredging out the material and depositing it in the banks on either side. After this is done it is designed to pump out the water from the rest of the Y, and thus to secure 12,000 acres of good land. This is considered entirely practicable, and the company estimate the reclaimed land to be an important part of their compensation.

---

*Polder is the Dutch name for a plot of reclaimed ground surrounded by a dike.

The Zuyder Zee, though covering a large surface, is quite shallow, and the project of dyking it off from the North Sea, and then pumping the water out of it, is now under discussion. The work is one of great magnitude, and must take a long time to get in operation, but it is neither impracticable nor visionary. The whole of it covers an area of 1,200 square miles; but part of it may be divided off for completion at first. The Haarlem Meer polder includes 18,000 hectares, which this year are worth 1,200 florins per hectare, or nearly $200 an acre; and the whole is worth 21,600,000 florins, or $8,640,000.

The following rules in regard to the construction of dikes are copied from Storm Buysing's Hydraulics, the standard text-book for Dutch engineers:

"Form of Dikes.—Dikes in general should have height enough to turn water; and by their form and the material of which they are made they should possess strength enough to withstand the pressure which water and other forces bring to bear against them. Hence they should rise at least from twenty inches to two feet above the highest known level of the water. Their shape should be that of a trapezium. They must be made of good adhesive earth, and they must not only be mutually united together in all parts, but also with the foundation on which the dike is laid. The breadth ot the top may vary from nineteen inches up to twenty, twenty-three, and even twenty-six feet. The outer slope has an inclination of from two to eight and even ten base to one rise. The inner slope is just enough to hold up the earth; usually from one and a half to two base to one rise. It may even be necessary in some cases to give the inner slope a curved outline.

"The Fore-shore.—The dikes are generally separated along their outer and inner borders from the adjacent lands by ditches, and the spaces between the ditches and the foot of the slopes are called the outer and inner *berm*. The breadth of these vary—for the outer berm thirty-three feet and for the inner one twenty feet is usually thought sufficient. Sometimes these berms are left as the natural surface of the ground raised them; but in case the land is not smooth and regular, they are often brought up to a uniform height, when they aim to lay them with a gentle slope, say one in twenty from the bank outwards, so as to facilitate the running off of surface water.

"Experience shows that the dikes which lie directly on the brink of the shore are much more liable to injury than those which lie further in, and have some land before them; and however much ideas may differ about the minimum of breadth in the different circumstances, which depend upon the position, yet all are agreed as to the supreme importance of this protection; and in laying out new dikes and diking new polders this must be looked to.

"Most of our existing systems of drainage lack this protection, and lie directly exposed to the force of the waves or current; yet these dikes once had land in front of them at most points, but it has been slowly worn away by the action of water. Now, to change the situation of the dikes is impossible, and we must limit ourselves to the employment of the best means of defence, and regulate these according to the situation.

"In laying out new dikes the first consideration is that the species of earth be suitable for making and keeping them up. Material for the outer dikes must be had without coming nearer to the dike than the outside line of the berm; that is, along the shore an edge of unbroken earth must be left of from thirty-three to sixty-six feet wide; and at intervals of perhaps three hundred and twenty-five feet jetties or projecting banks of earth twenty feet wide, standing out at right angles to the line of the dike, should be left to supply material for the repair of the dike, filling holes, or for other uses of the like character.

"Along the banks of great rivers, and along the seashore, the berm or fore-shore is sometimes made much wider, even to 325 or 490 feet.

"LOCATION.—In selecting a location for dikes on new ground, there are many more circumstances to be considered than for determining the fore-shore—first, the direction must be such that with the shortest dikes the greatest surface possible may be enclosed; second, the dike must as far as practicable run parallel with the stream or else at right angles to it, and, third, that direction must be avoided which would be exposed to our prevailing storm winds from the southwest, west, and northwest. But above all the quality of the ground on which to found the dike must be considered, and the firmest and highest possible selected, and that which is not cut up by brooks or low ground. When corners or tongues of land come in the way, it is to be decided whether their outline should be followed, or partly cut through and diked, as in cases where the cost of a longer dike may not be compensated by the increased value of the piece of land to be diked. The line of the dikes must avoid all acute angles, and when necessary, making them outward rather than inward, because they hold the water driven by the wind better than the others. Different lines can be united by curves, to which the two are both tangent.

"FOR THE CROSS-SECTION of a dike it is not enough to obtain strength, but sufficient strength to resist the force of the water on the dike must be obtained at the lowest possible cost. The height forms the first consideration; the highest water levels ever to be expected at that point form the guide to this, and observations of extraordinarily high freshets after storms give them. Those of January 14 and 15, 1808, February 4, 1825, and February 24, 1837, are the highest ever known, and rose as high as seven and a half to eight and a quarter and even nine feet above the ordinary high-water mark, varying with the position as regarded wind at the point of observation. These heights were measured with perfectly smooth water; the waves are by no means equal. Where dikes turn from the wind there are scarcely any waves, so that a dike from two to two and a half feet above the highest known water level is quite sufficient for these. While in dikes affected by the storm wind the waves rise, according to observations taken in Zeeland, as much as eight feet above still water. The waves are higher where the dike is without a berm and has great depth, than where it has a high and broad berm. They also rise on steep slopes much higher than on more gradual ones.

"The height of the dike must be most regular, sloping from those points most menaced by waves down to such parts of the dikes as are protected from the wind, where less height is requisite.

"For example, the Southern Dike, between Rammekens and Veissingen, on the island of Walcheren, is only ten feet above high tide, while it rises at Veissingen to sixteen and a quarter feet. The Westkappel Dike, which is also very favorably situated with regard to the wind, is fifteen and a quarter feet above high-water mark.

"On the Island of Schourien, when the Dike of Scharrendijke was improved in 1842–3, it was raised to twenty-one feet above high water. Other less exposed portions along the Zeeuw streams are from ten to eleven and a quarter feet above.

The Helder Sea Dike from the end of the dunes at Huisduinen on to Nieuwe Diep, running almost east and west, and consequently much exposed, is from twelve and a half to fifteen and a half feet above ordinary high tides; the other North Holland dikes along the Zuyder Zee are from eleven to twelve feet. The Gelder and Overyssel dikes average from eleven to twelve and a half feet; those in the vicinity of Vollenhoof are thirteen feet above, and those along the coast of Groningen from thirteen to fifteen and a quarter feet above.

The height above ordinary high and low water thus regulates the height given in descriptions and plans, and this is indicated by immoveable marks at different points, such as bolts, beams, or panels in sluices, or similar things. The ordinary tides are thirteen feet or less.

"The breadth of the top of the dike varies from twenty inches to twenty, twenty-three, or twenty-six feet. The first consideration here is the strength required of the dike, and the second whether the top shall or shall not be used for carriages and horses. Riding on top of the dike is generally considered as injurious to the dike and dangerous for the traveler, nevertheless it seems advantageous to give so much breadth to the tops of the dikes that they may serve as roads when needed; for in time of danger they are often of great service for the transportation of materials, while in case of overflows they afford communication for a long time when the ordinary lower roads are made impassable by the water. Hence where the ordinary roads do not cross dikes a breadth of at least ten feet should be left, while on such as usually serve the purpose of roads from sixteen to twenty feet is necessary. .

" On the inner side that slope is taken at which the soil is in no danger of sliding down; the most cohesive soils will almost stand with a slope of one base to one rise, less cohesive one and a half to one, and always with an inclination of from one and three-quarters to two rise to one base. If the dikes had only to resist the pressure of the water on their sides, then (providing the dike were of good adhesive material) the cross-section might be triangular in shape, the side slopes of which should have the natural inclination of the earth; but this is not advisable, since perfect coherence and solidity are never attainable in a raised mass of earth, and this lack must be supplied by a greater amount of earth. Again, the jar of the water and the motion of the waves form the chief cause of the destruction of dikes, and hence the outer slope, which has first to resist this force, must be put in condition to withstand it.

"The force with which water and other bodies come against a slope, increases in proportion to the angle made by the slope with the horizon, hence a slight inclination affords more resistance than a steep one, which experiments have confirmed.

" According to theories advanced by Woltman on the effects produced by water and ice upon dike slopes, sea dikes are effectual with less strength at their foot than nearer the top, and a convex surface should be chosen for the outer side of sea dikes, though a smooth form should be retained where the slope varies but little.

" The consideration that the ice is never driven by low water against the dikes, but always at high tide, and that the beating of the waves against these dike slopes can be injurious only when the winds are in a certain direction and at high tide, naturally leads to the conclusion that the slope below high-water mark may be less smooth than above. As the portion of the slope below high water is unfavorable to a natural covering of grass, it must be artificially protected, and this protection is less costly with a steep slope than with a gentle one. As all sudden crossings and sharp angles are to be avoided, the outer slope should have a convex form.

" The Species of Earth of which the dikes are made must be such as will cohere and hold firmly to the foundation; the more cohesive the earth the more desirable it is, and the more solidity may be expected from the dike. Hence clay is the most desirable material for dikes, and it can generally be found along our coasts where dikes have been or must be laid. Sometimes they are made by preference from alluvial earth, where clay is not near, and its transportation would be too costly and troublesome.

"Sand has very little cohesiveness and will not make strong, water-tight dikes; pasture or marshy earth has too little specific gravity, frequently even less than water, and hence must be excluded with sand from the dike.

"Garden and surface soil, though far below clay, still as its fine particles readily pack, is much more desirable than pasture ground or sand, particularly for covering slopes where grass is wanted.

"The clay is not always pure, nor always obtainable in sufficient quantities, so that a mixture of clay and poor earth must often be used. But if care is taken to put the best and purest clay on and near the outer slope, and the poorer kinds in the body of the dike, then such kinds may be used without much danger. There are instances of dikes made from very sandy soils, with a covering of only three feet of clay on the outer slope, which, nevertheless, turned water well. Such layers of clay should be used with the utmost care and every little injury must be immediately repaired, for if the ground once give way so far as to admit the water to the sand or poor earth, little dependence can be placed upon stopping the water.

"Before commencing the making of the dikes, direction and profile are carefully marked out on the ground, and the precise borders of the inner and outer banks, marked with a sharp instrument. Within these the sods are torn up as much as possible, and the ground always dug up deep seven to eight inches, made soft and cleared from all roots of trees, plants or anything which might hinder the proper cohesion and union of the soil. The sods, both from under the dike and from the ditch, are to be carefully piled up to be afterwards used in covering the new work. As the outline of the dike and size of the ditch are enlarged, it will seem that the new dike is to be higher than that previously calculated for, for the earth is not so firmly united when first dug out as it subsequently becomes through the weight of the dyke and the evaporation of the water, but the subsoil will also be more or less pressed down by the weight of the dike until the resistance of this packed subsoil equals the weight imposed. It is difficult to give a definite idea, as the position of the foundation depends upon the nature of the ground, the weight of the dike and the extent of the surface necessary to support this weight. The greater or less sinking of the body of the dike depends partly on the greater or less firmness and humidity of the soil, but also much upon the carefulness of its treatment. So the height of the dike is made one-seventh or one-tenth greater according as more or less sinking is expected, but the breadth of surface remains the same that it is to be after the final settling of the height of the dike, so that the inclination of the two slopes is steeper. But since the top of the dike will sink most, as most earth is heaped there, and the ground has at just that point to bear the most weight, while on the contrary there is no sinking at the foot of the slope; after its final settling the dike will have less inclination.

"The banks are built in thin layers and packed by the constant passage of horses and carts, and sometimes by means of stamps or by puddling.

"The planting of dikes with trees may be very advantageous; along genuine sea dikes it is impossible to keep them alive; but dikes less immediately exposed to the sea air are often planted with trees. The rapid drying of the dikes renders the growth of wood slow, and the grass grows thin and poor under them, while the motion of the trees in high winds, affecting the roots, loosens the soil, so that it seems unadvisable to plant dikes where trouble in resisting the water is anticipated. Whenever there is an opportunity to plant osiers and willows along the dike, at a distance of twenty or twenty-six feet, such planting is highly desirable for it destroys the power of the waves and of ice, thus strengthening the dike. The osiers and willows are generally cut every three or four years. In order that the dike may never be exposed, an arrangement ought to be made to cut a part every year, so that the larger portion of the protection may remain standing."

In concluding these statements regarding the success which has attended drying the low-lying lands of England and Holland, I may call attention to several points separately.

1. From the statements made it is obvious that the reclamation of salt marshes or lands liable to be overflowed by the tide is attended with a heavy outlay of money. In the English fens the expenses have come in so many forms that it is not possible to get them together, but they have been enormous. In the Netherlands, also, the expenses have been wonderfully large; the dikes on the Island of Walcheren, which is on the most exposed part of the coast, have been several times almost destroyed, and it is said they have cost money enough to build them of solid copper. In our own State the Swartwout improvement on the Passaic and Hackensack marshes, in 1830-6, failed from not being thoroughly carried out; and the later enterprise of the nurseries on the same ground, was brought to an end from an unwillingness to invest money enough in it to construct substantial banks and sluices to

shut out the tide and drain off the water; and in our southern counties where diking is a success, there have been many heavy losses from the failure to put in a sufficient amount of money and labor to build solid and permanent banks. To make the dikes stand they must be built of earth, or at least must have a core of earth, and not be entirely of peat or spongy sods. The foundations must be more carefully prepared. Along the banks of rivers and streams the ground is usually solid enough to hold up the dikes, but it should always be sounded for old sloughs or water-courses, which, though covered with solid earth, may still be very soft and insecure. In all banks crossing the marshes away from the water-courses the material of the marsh is soft and yielding, and secure banks can be built on such ground only by making a core of puddled earth in the bank from the solid ground under the marsh up to high-water mark. The peculiarities of our marshes in respect to solidity of material were plainly shown in the maps accompanying the Geological Report for 1869.

The expenses of reclaiming lands will be least when the largest plots are enclosed within the same bank. The bank for a large plot needs to be no heavier or higher than for a small one.,—and the lengths of bank to go around fields of the same shape are in proportion to the square roots of their areas. It takes but twice as long a bank to go around four hundred acres as it does to go around one hundred,—but three times as much to go around nine hundred acres—and only four times as much to go around sixteen hundred acres. The Dutch *polders* or plots of enclosed and drained ground formerly averaged about twelve hundred acres each, but the newer ones are much larger; the Haarlem Meer polder contains 45,000 acres, and all the projected new ones are very large. The drainage districts in the English fens are also very large, the smallest of them including many thousand acres. It is by dividing the expenses over so many acres that they are made light enough to be paid and still leave the farmer a margin for profit.

It should also be remembered that when our drained lands settle so much that they cannot be longer drained by sluices, then pumps will have to be used. The amount of rain that falls in this country is nearly double that of England or Holland, and, of course, will cost twice as much to pump it up so as to run it over the dikes.

And finally when such costly works are to be undertaken, the plans for their location and construction should be entrusted only to skilled engineers and workmen. By this means the parties interested may have a fair understanding of the expenses they must meet, and also a reasonable prospect that their improvement will be a permanent one when done.

2. *The worth of these lands when properly reclaimed can hardly be overestimated.* Wherever there is a sufficient amount of clay or mud mixed in with the grass roots and other organic matters of the marsh it will make a soil inexhaustibly rich. When such lands are brought into cultivation, with good management, they can always be depended on for yielding large crops. They are easily tilled, and cost less than other lands for fertilizers. The water level being only two or three feet below the surface, crops upon them are very little, if at all, damaged by droughts.

It should, however, be distinctly understood that marsh lands are not all composed of soils like those mentioned above; very large portions of marsh lands are found in which there is no earth, clay or mud, nothing but muck and grass roots or turf. Such lands will not produce crops without manure; and to make them really good soils, they must be clayed like the English fen-lands, which have been described, or else have upland earth put on them to the amount of two hundred or three hundred yards per acre, and must be fertilized with mineral manures like uplands. Lands of this quality will sink very much when drained, and in many places may become so low as not to be capable of drainage by sluices; and they will very soon need pumps to drain them. When remote from market, it is very questionable whether it will pay to give them the *thorough* drainage which is needed for cultivated land. In the neighborhood of Salem some of the drained meadows are only used for growing grass, and not cultivated. This is the case also in Holland, where by far the largest part of the drained land is in meadow or pasture, and is considered to be more profitable than the arable land. The water needs not to be kept so low in the ditches, the cost of drainage is lessened, and damage from floods is much less to be dreaded. Pasturage and the raising of hay may possibly be adapted to these flat grounds to an extent much greater than has yet been reached.

The improvement is well begun, both in East and West Jersey, and there is abundant encouragement for continuing it. There is room, however, for failures, and every project for drainage should be carefully examined and well understood before its execution is undertaken.

3. The effect of draining marsh lands upon the health of the adjacent country, is a most important subject of inquiry. The English Fens were formerly noted for generating fever and ague. They are universally conceded to be much more healthy now than before they were so well drained. And though I inquired frequently, I could not learn that the drained lands were considered less favorable to health, than the drier uplands. In Holland one of the strong inducements to drain the Haarlem Meer was to do away with the sickness which followed the floods, overflows, and consequent stagnant water caused by storms driving across the lake. No injury to health has been observed to follow its drainage.

There was some sickness in the polder in 1868, but it was not serious, and there is no reason for connecting it in any way with the drainage.

Some lands in our own country are said to have been made unhealthy by drainage for a year or two after the work was done; and such might possibly be the case with these newly drained land. It is not likely to be so however, and in the end the general healthiness of the country must be improved.

Musquitoes and green-headed flies, those pests of our salt marshes, would certainly find a less favorable breeding ground if the water was all drained from the surface, and this of itself would be a great saving to the community. It would tend greatly to the comfort of human beings, and would save the stock of the country from a vast amount of worrying and loss of flesh. I saw a few gnats in the English fens, but none in Holland. The season was late, however, when I was in the latter country.

Our muskrat, which is so troublesome to the managers of dikes, is quite unknown in Europe. They have a water-rat which burrows in the banks of streams, but he is by no means equal to our muskrat in his power to do damage.

In writing these cautions in regard to planning and managing works of drainage, I do not desire to discourage them, for such lands are by far the most profitable and productive of any that I have seen abroad. We have large areas of lands capable of such improvements; it is for the interest of the owners and of the whole community to have them improved. And the experience which has been gained both at home and abroad is sufficient to indicate the proper way of making them.

III.

On the Soils of the State, their Origin, Chemical and Physical Properties, Distribution, and Suggestions for their Most Productive Management.

A large number of soils have been collected from different parts of the State, and most of them have been analysed. There is, however, much more to be done in this department of the survey, and the results will be presented together in a special report upon the subject.

For the purpose of calling out information which may be in possession of some of our intelligent farmers I reprint from the report of last year the average of a large number of soils and subsoils, from the rich valleys of our own and the neighboring states, which are underlaid by magnesian limestone. The first column gives the soils and the second the sub-soils.

ANALYSES.

Silica	67.88	65.31
Per-oxide of iron	4.57	8.11
Alumina	12.88	13.10
Oxide of Manganese	.44	.37
Lime	..96	.59
Magnesia	1.47	1.34
Potash	2.90	3.87
Soda	.43	.69
Phosphoric Acid	.78	.80
Sulphuric Acid	.03	.04
Organic Matter	6.61	3.72
Water	1.61	1.70
	100.56	99.64

These soils have been noted for their fertility, and have been cultivated ever since the first settlement of the country. They are specially adapted to the growth of wheat, and have always yielded good crops even under the worst of management. The analysis shows that they contain an abundance of all the essential elements of fertile soils; the phosphoric acid, potash, lime, magnesia, and sulphuric acid. The practice of farmers is to enrich these soils by the addition of lime, and by raising clover. It is not thought profitable to keep any stock upon them except sufficient teams to do the work. Plans to increase the supplies of barn-yard manure, like those pursued in less favored soils, are not thought necessary. Lime causes the mineral ingredients to become soluble, and clover supplies the elements of ammonia.

For comparison with these I present the analyses of two soils from the Miami Valley, in Ohio. The Specimens were collected by my associate Prof. Jacob Cooper, and analysed in the state laboratory. The first was taken from a fence border and has never been cultivated. The second is from a field which has been cultivated eighty years without manure and still yields excellent crops.

ANALYSES.

Silicic Acid and Sand	57.60	65.20
Per. Oxide of Iron	2.23	3.78
Alumina	2.18	3.89
Lime	9.43	4.65
Magnesia	4.44	3.90
Potash	0.23	0.43
Phosphoric Acid	0.29	0.29
Sulphuric Acid	.11	.11
Carbonic Acid	10.35	5.85
Chlorine	.03	.02
Organic Matter	9.70	7.23
Water	3.05	4.10
	99.64	99.45

Analyses like these joined to the experience of farmers in working the soils, must finally help to explain some of the difficuties in agricultural science, and I would invite correspondence on the subject.

IV.

On the Iron and Zinc Ores of New Jersey.

The mining of iron ore has been actively carried on during the past year. No accurate statistics have been collected to show the whole amount that has been mined, but it is said to be considerably larger than in any former year; and the demand for our ores is increasing more rapidly than the supply. It is proposed to re-examine and extend the survey of our magnetic-iron ore district the coming season. An examination of some of the large mines of magnetic iron ore in Sweden will furnish a subject for comparison with ours, and a report upon our mines, embodying also the results of the visit to the Swedish, German, and English iron mines, will be prepared as soon as possible.

The zinc mines of our State continue to yield an abundance of ore of the best quality.

V.

Additions to the Scientific and Economic Geology of the State.

THE COPPER ORES OF NEW JERSEY.

Ores of copper have been found in various places since the first settlement of the State. The mines at Belleville, Somerville, Flemington and New Brunswick, have been woked at different times for a hundred years past.

The ore is disseminated through the Red-sandstone or is found near the meeting of that rock with the trap. It is not uniformly distributed, and mining it has not been profitable.

There is an immense quantity of rock discolored by the one or two per cent. of copper which it contains, and some of the new processes for extracting copper show ore as lean as this to be worked with profit. While abroad I visited the copper works at Stadtberg, some thirty miles west of Cassel, in Germany. A thick stratum of black and flinty slate that contains from a quarter per cent. to two per cent. of metal is the source from which the copper is obtained. The ore or rock is partly worked in an open quarry, and partly by underground mining, and being in large quantity is got out at small expense.

When visited in October the mine was producing about 2,500 tons of ore a month, and the average yield of copper was one and a half per cent. The metal is extracted from the rock by acids, and not by heat and furnaces, as is usually done.

The ore is taken directly from the mine without roasting or drying, and is crushed to fragments. The pieces are not as large as hickory nuts, but the greater part are of an appreciable size and not in powder. This crushed ore is put in vats of perhaps a hundred tons capacity, and is then covered with dilute muriatic acid; the quantity of acid being regulated so as to suit the amount of metal in the rock. The acid is drawn off at the bottom of the vat from the rock, and pumped on the top again several times in the course of the three or four weeks required to extract the copper. The liquid which holds the copper in solution, when it has been brought to a proper strength by acting on different vats of ore, is run into a vat where it can be kept in motion by a revolving agitator, and scrap sheet iron is added to it to precipitate the copper. It is soon entirely separated from the liquid, in the metallic state, but in the form of powder or small spongy grains. This precipitated copper is separated from the remaining scraps of iron by tumbling them in a cask perforated with holes through which the copper gradually sifts out. The copper is then taken to the smelting furnance and refined and prepared for market in the usual way.

The whole process is carried on very economically, labor is low, not more than one-third of our prices, and the acid is cheap, being the waste product from a soda factory; costing from one and a half to two cents a pound at the works; the liquid from which the copper has been precipitated is used over and over again as long as there is anything valuable in it, and the sediment of oxide of iron which settles from the waste liquids is dried and used for paint. The ores which contain five per cent. or more of copper are picked out and worked in the dry way. The buildings and apparatus are of the most inexpensive kind—mere sheds answering for the former, and wooden vats backed with clay being all that is used for holding the large quantity of rock which has to be acted upon by the acid.

With very careful management the process has been carried on profitably, even upon ores containing only a quarter of one per cent. With the present low price of copper, however, the managers are not so well satisfied with the profits as they have been.

An immense quantity of ore as rich as that of Stadtberg can be found in New Jersey, and descriptions and localities of it are given in the Geology of New Jersey, pp. 219–224 and pp. 675–680.

When at the German works the question arose as to whether the process used there upon the hard black slate was applicable to our softer and more ochrey rocks, and for the purpose of testing this question, some trials have been made in the State Laboratory, upon two of our New Jersey ores, with the following results, viz:

1. A common sandstone, discolored with the green carbonate of copper which appeared to have penetrated it everywhere, was analyzed and found to contain two per cent. of copper. This sandstone was pulverized and mixed with two and a half per cent. of commercial sulphuric acid. After di-

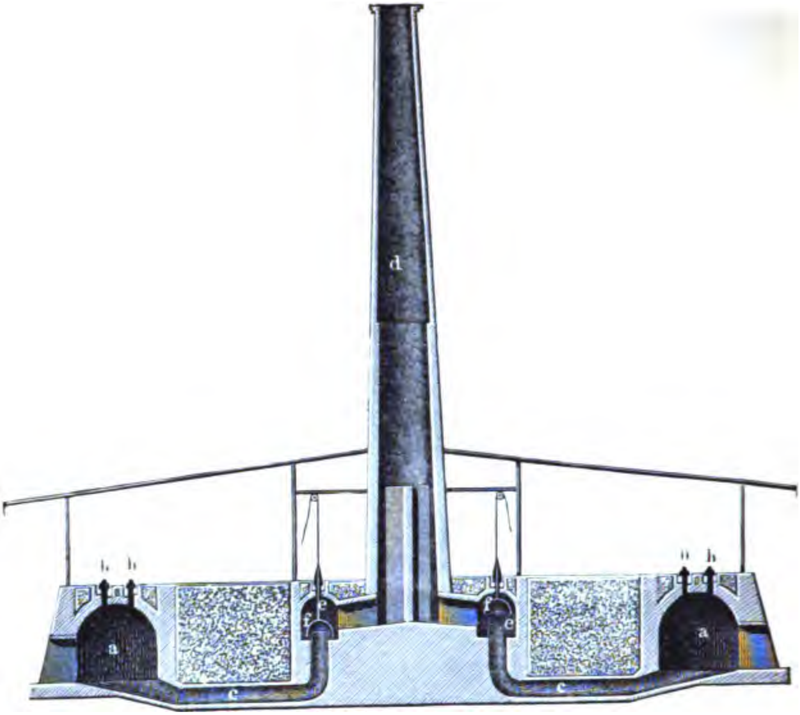
gestion the liquid was drawn off, and the copper that had been dissolved was precipitated. About one and two-tenths per cent. of metal were obtained from this first digestion, and very little of the oxide of iron or alumina in the rock was dissolved.

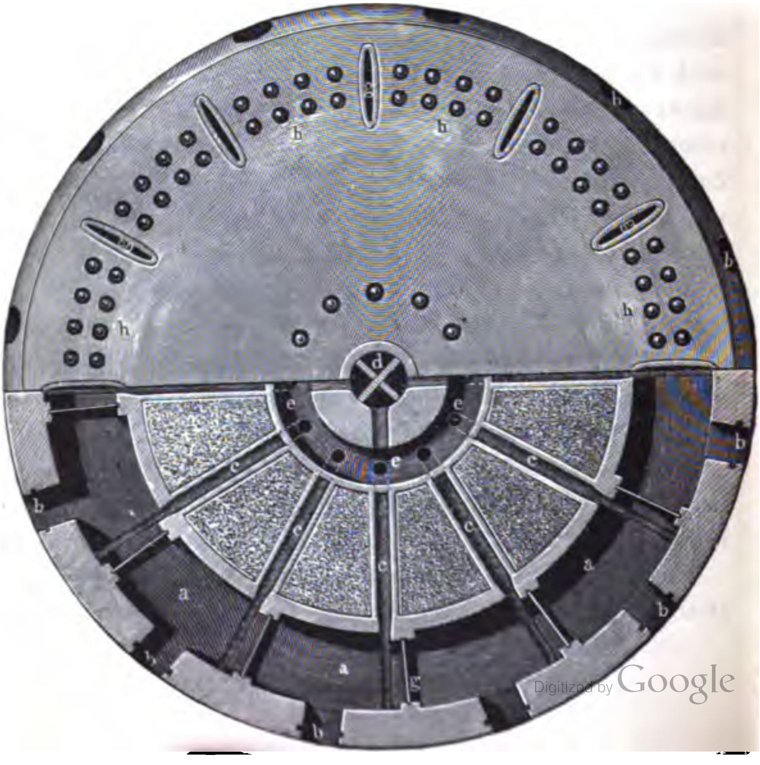
2. A specimen of shale, blue with carbonate of copper was analyzed and found to contain six per cent. of copper. A quantity of acid more than sufficient to dissolve the oxide of copper was put on the crushed ore and digested. The proportion of copper dissolved was not so great as in the other, and the acid was consumed in dissolving a quantity of carbonate of lime and magnesia which exist naturally in the rock.

The experiments show that the process is applicable to our copper ores in Red sandstone rocks which contain oxide of iron and alumina, but is not applicable to those which contain much carbonate of lime or carbonate of magnesia.

ON BRICK MAKING.

The use of bricks for building, is constantly on the increase in all the older sections of our country. And the advancing price of lumber must tend still further to turn the attention of builders to bricks as a material for construction. We have immense beds of brick clay both on the east and west sides of the state, lying on navigable waters, so that they are within cheap communication of the great markets. While in Berlin I had an opportunity of witnessing the working of a new form of Brick Kiln which is said to require only a third or even a quarter as much fuel as the old mode of burning. Berlin is almost entirely built of brick, two hundred million large brick are used there every year, and they are all burned in these new kilns, the older mode having been entirely driven out of use there, since 1859, when the present were introduced.


d
b
b
a
f
e
c
e
f
c
a
b
b


b
h
h
h
h
b
d
e
e
e
c
c
c
c
c
c
b
b
a
a
a
a
b
b
g
b

The ingenuity with which these kilns have been made to apply well known principles of science, and the success which has attended their introduction abroad, leads me to present an illustration of them, in plan and vertical section. The kiln is a permanent structure built of bricks, and the burning is carried on in an arched passage way that has the form of a railroad tunnel, only it curves round so as to return into itself and so make a complete ring. The letters *a. a. a. a.* in the cuts show this chamber. This is connected with the chimney *d. d.* by several flues, in the cut twelve, marked *c. c. c. c.* The ring-like chamber or passage has doors or openings *b. b. b. b.* entering it through the outer wall. There are as many of these as there are connecting flues, and it is intended to have as many of each as there are working days from the time of putting in the green brick to the time when they can be taken out, burned and cool. This kiln is for twelve days work. The flues on their way to the chimney pass into an annular chamber marked *e. e. e. e.* where each one is provided with a seperate valve or stopper *f. f.* The vertical section shows one open and another shut. Between each two doors or openings *d.* are grooves built in the side walls, into which dampers or partitions can be lowered as shown in *g. g. g.* on the part of the plan which has the covering represented. By means of these the whole chamber can be divided into twelve compartments each with a flue and doorway. When working however only one damper is in its place, all the flues are closed except one, and all but two of the entrance doors are bricked up. The round openings marked *h. h. h. h.* are intended for dropping in the fuel, and are usually covered with a loose piece of sheet iron, or brick. All the space inside the annular kiln is filled in with sand or other cheap material.

The working of the furnace can now be easily understood. If the observer is supposed to face one side of the furnace where he can see the two open entrances which may be numbered (1,) (2,) and so on from right to left, he will see men placing green bricks in the compartment (1) and taking out finished bricks from (2). The damper or partition is in between (12) and (1) and the flue from (12) is open. The fuel is being fed in small pieces at a time, into (7.) This is done by dropping it through the small holes in top of the arch, and allowing it to fall among the red-hot bricks which were laid in so as to allow of this mode of dropping in the fuel. As the kiln is in constant operation and each day a new compartment is filled and one emptied, it will readily be understood that (3,) (4,) (5,) and (6,) are filled with brick which have been burned respectively four three two and one days, and that (8,) (9,) (10,) (11,) (12,) are filled with unburned bricks that have been in respectively five, four, three, two, and one days. The air which is to consume the fuel to burn the bricks is entering at the openings (1) and (2) and is drawn through the burned bricks taking up heat from them and growing hotter and hotter until by the time it reaches the fuel it is almost red hot, and ready to make a genuine hot blast for the fire and it does make a remarkably hot and clear fire. The air and gases from the combustion then pass on through the unburned brick, heating warming or drying them, and giving up its own heat so that when it reaches the chimney it is almost cold again. To-morrow (8) will be fired, and so on.

In principle it is admirably arranged, and in practice it burns the bricks evenly so that very few are damaged,—the labor of firing is very light, and needs no skill,—the amount of fuel is small, much less than in the ordinary kiln, and the quality of the fuel is very common; coal dust, chips, fine peat or any other refuse that will burn at all, can be used :—our anthracite coal dust should find a use in this kiln.

I visited the works near Potsdam where many of the bricks for Berlin are burned. There were thirty of these kilns within a circuit of two or three miles, each of which was turning out from one and a half to three million bricks a year. The fuel used is a poor quality of turf, very light and crumbling, worth at the works two and one fourth thalers a klafter, or about fourty-four cents a cubic yard, which is the quantity they were using to burn one thousand brick. The size of the brick is eleven inches by five and a half by two and three-fourths, which is twice as large as ours.

The kiln is patented by Frederick Hoffman of Berlin, and he has already three hundred of them in Prussia, and as many more in different countries of Europe. In our own country twelve or fourteen of them have been put up, and are now in operation. Hoffman's agents in this country are Wedekind & Dueberg, Baltimore, Maryland. They have a kiln there in which they claim, to turn out 15000 brick daily, with a consumption of one ton of coal or at an expense of thirty-three cents a thousand, for fuel.

The kiln is equally well adapted to the burning of lime, or of pottery.

If so large a saving as that of two thirds the fuel, can be effected, by this invention it is a matter worthy the attention of our brick makers; and I gladly call attention to it.

ON THE DRIFTING SANDS OF THE SEA BEACHES.

When in Holland my attention was called to the care taken to fix their sand dunes, and prevent them from drifting over the meadows and cultivated grounds. For this purpose they plant common *beach grass*—known to botanists as the *Arundo arenaria*, *Ammophila arundinacea A. arenaria*, *Psamma arenaria*, *P. arundinacea*, and in Gray's and Wood's botanies as *Calamagrostis arenaria*. It is known by the common names of *sea-reed*, *sand-reed*, *bent*, *marrum*, and *star* or *mat-grass*. The same species which grows in England and Holland, is found on our seashores. It grows in the dry, drifting sands of the sea beaches, and thrives nearer to the salt water than any other dry-land plant of vigorous growth. All domestic animals reject it as food, but its numerous wire-like leaves successfully withstand the blasts of wind and sand which are driven across the beaches, and retain their erect position, and with their thick matting, tough and spreading roots, restrain and hold in place the drifting sands which otherwise continue to move inland, overwhelming and destroying everything in their way. When this grass gets well rooted it holds the sand, and makes it a protecting barrier instead of a moving destroyer. This property has been so well understood abroad, that stringent laws for its protection have been passed in England, Scotland and Holland, and they are strictly enforced. In England it is a penal offence for any one, the lord of the manor not excepted, to cut or pull the *sand-bent*, or to be found having it in possession within eight miles of the coast.

The sand-dunes along the coast of Holland, almost west of Amsterdam, are entirely bare of trees, and some of them nearly one hundred feet high. The winds sweep across them with more violence than any of the storms that visit our coast, yet they are held in place by this grass. The Great Canal from Amsterdam to the North Sea cuts directly through them down to the sea level, and the sandy banks of the canal are being planted with this grass at once. That set out last spring had grown and was covering the surface well, and the work of planting was still in progress when I was there on the 18th of October last. The grass is propagated by transplanting its roots and not by sowing the seeds. The plants are taken from any old plantation where the sand is full of roots. From five to ten spears of the grass with good roots, are set together in the loose sand, holes for the bunch being opened with a common trowel to the depth of from eight to twelve inches. They are set in rows eighteen inches apart, and the plants are eighteen inches apart in the rows. The work was done in the same way that cabbages are set out, and very rapidly. In that climate there was no difficulty in making the plants grow.

The sea is making great inroads on our shores; two Surveys, made about thirty years apart by the U. S. Coast Survey, show that our entire coast from Sandy Hook south for twelve miles, has either washed away or been moved inland nearly a hundred yards. Probably the same thing is true of the entire coast to the south point of Florida. This sea-bent is one of the easiest means of holding the sea in check. Our beaches will grow cedar and other valuable timber if the force of the wind can be checked long enough for them to get started. Hitherto no care has been taken to preserve the timber on the beaches, but whenever it was wanted it has been cut off, and the ground left open to the full sweep of the winds; soon the sand is all in motion, moving inland. New growths of wood could soon be started if the sand was fixed by a mat of grass. Our climate is hotter, and it may be necessary to have more regard to the season, transplanting in spring or autumn rather than in the heat of summer. In some places the land washed away is of little value, but in others it is very important in itself and for the protection it affords to other property. Premiums from our agricultural societies might be used to call out competition in the cultivation of grass or trees on our sea beaches.

APPENDIX A.

Report of Levels and Soundings taken on the Passaic River from Chatham to Millington Bridge, and also on Dead River, by Prof. Ed. A. Bowser.

A line of levels was run from Chatham Bridge to Millington Bridge, and also on Dead River as far as the second bridge from its mouth. From these levels the heights of the benches were determined at all the intervening bridges. The heights along the surface of the water were found by leveling from these benches. The heights along the *bottom* were determined by sounding in the channels of the rivers, and subtracting the depths from the heights of the surface. In the accompanying profiles, the top of Beatty's Dam, at Little Falls, is the datum plane. The heights of the points, both along the surface and the bottom of the rivers, were measured from this plane.

It will be seen, by a careful examination of this profile:

1st.. That the bed of the Passaic from Chatham Bridge to Page's Dam, has a rise of twenty feet, while each dam, viz: the first just above Chatham Bridge, the second, Edward's, and the third; Bunnell's, backs the water up to the dam next above it.

2d. That the bed of the river from Page's Dam to Smally's Bridge, distant eight miles, following the course of the channel, has a rise of six feet, while the bed of the river at Smally's Bridge is two feet *lower* than the top of Page's Dam.

3d. That the bed of the river from Smally's Bridge to the mouth of Dead River rises five feet; from the mouth of Dead River to the bridge opposite the Church, two feet; from the Church Bridge to Millington Bridge, five feet. On Dead River, from its mouth to the second bridge three miles up, it rises eight feet.

We see then that while the river, from Page's Dam down to Chatham Bridge, has a sufficient fall, Page's Dam must back the water up to the mouth of Dead River. So that an ordinary rain, when the mill-pond is full, will flood the Passaic Valley from the dam to the mouth of the Dead River.

By the "New Formula," deduced and used by the Hydrographical party, in their investigations on the Mississippi, a fall of eight inches per mile, in a stream the size of the Passaic above Chatham, will give it a velocity of about one and a half feet per second. This fall can be obtained by cutting Page's Dam down eight and seven-tenths feet, which will make the grade line at the dam thirty-seven seven-tenths feet above the datum plane. This grade line prolonged will strike Bunnell's dam two feet below the top, or thirty-seven feet above the datum plane. Bunnell's Dam, therefore, will require cutting down two feet.

The grade line between Page's Dam and Turkey Bridge, as the profile indicates, is from two to three feet below the bed of the channel, and about half a mile above Page's Dam it is five feet below the bed, and the bottom is rock. Between Turkey Bridge and Townly's Bridge, the bed of the river, wherever the grade runs below it, is mostly loose earth and sand bars, which, with a little work, will be washed away by the action of the running water when all obstructions below Turkey Bridge have been removed. At Townly's Bridge the grade is forty-one and one-half feet above the datum plane, or one foot below the bed of the channel. From this bridge to the mouth of Dead River, and on Dead River, to the second bridge, the grade is from one to three feet below the bed of the river.

Dead River and the Passaic, for half a mile below the mouth of Dead River, have at present a *fall* sufficient to carry off the water if the obstructions below were removed, but they are entirely to *shallow.* For this reason it will be desirable to cut them down to the grade line to furnish a channel sufficiently deep to keep the water within its banks and below the surface of the ground. The work of doing this will not be great as the most of it is loose earth, not having had any current to wear it away. From about half a mile below the Church Bridge up to Millington, there is at present a large fall. To drain this valley, then, requires that the bed of the river be cut down to this grade line; and this will necessitate the destruction of Page's Dam and at some future time the lowering of Bunnel's Dam.

When this is done, and only when this is done, the Valley of the Passaic from Millington to Chatham, and also the Valley of Dead River, can be well drained.

The principal cost of this improvement will be in paying for water-power that will necessarily be destroyed.

LIBRARY
Leland Stanford, Jr.
UNIVERSITY

APPENDIX B.

Report of the Levels and Soundings taken on the Pequest River, in Warren County, by Prof. Ed. A. Bowser,

A bench, named first bench, was made on a maple tree on the right bank of the Pequest, 2,286 yards below Vienna, at the entrance of a valley running up towards Danville Church. The datum plane was assumed ten feet beneath this bench. A line of levels was run from this bench up the Pequest to Adam's Bridge, and also up Trout Brook to Trout Brook Bridge, and benches established at all the bridges and at intermediate points. The heights along the surface of the river were obtained by leveling from these benches. The heights along the bottom were determined by sounding in the channel, and substracting the depths from the heights of the surface. The heights of the points, both along the surface and the bottom of the river, were measured from the datum plane ten feet beneath the first bench.

By inspection of the profile, we see that the bed of the river, from first bench to Steam-mill Bridge, has a rise of ten feet, while the rise from first bench to the bed of the river, one hundred and ten yards above Steam-mill Bridge, is only four and a half feet, making the bed of the river at the latter place five and a half feet lower than it is just below Steam-mill Bridge.

The water in the river just below the Steam-mill Bridge, on April 14th, 1870, was three feet deep, while one hundred and ten yards above the bridge it was eight and a half feet deep, and two and a half feet deep on the surface of the meadows. If the bottom of the river, from the point one hundred and ten yards above the bridge where the water was eight and a half feet deep, could be made to have a fall sufficient to give the water a velocity of at least one and a half feet per second, its surface would be kept five feet lower than it is possible to keep it with the present reef at and below the bridge. If this had been the bottom on April 14th, the water surface, being five feet lower, would at that time have been two and a half feet below the banks.

By applying the "New Formula" used by Captain Humphrey and Lieutenant Abbott in their investigations on the Mississippi, we find that, in a stream the size of the Pequest on April 14th, a fall of one foot per mile would give it the above mentioned velocity of one and a half feet per second.

The grade line on the profile represents this new bed from the bottom of the river one hundred and ten yards above the Steam-mill Bridge, down towards first bench, with a fall of one foot per mile. It will be seen that at the Steam-mill Bridge the grade is eight and three-tenths feet above the datum plane and five and a half feet below the bed of the river, which is rock. At the first bridge above Vienna, the grade is four and three-tenths feet below the present bed of the channel—the latter rock—and continues from two to five feet below the bed of the river for three hundred yards. Just below Vienna Bridge is another reef three feet above the grade. Between Steam-mill Bridge and the first bridge above Vienna, there is considerable loose earth and some rocks, besides the three reefs, varying from one to three feet deep to the grade line.

It will be seen that the grade does not run below the bed of the channel between Vienna Bridge and first bench, while it reaches the latter five feet above the datum plane, or one and one-third feet above the present bed of the channel. Thus we see that the reef at Steam-mill Bridge can be cut down five and one-half feet, and the bed of the channel from that point down have a fall of one foot per mile, without any cutting below Vienna Bridge. This will be equivalent to removing a dam from Steam-mill Bridge, five and one-half feet in height.

The grade line on the profile, with a rise of one foot per mile, reaches Long Bridge eighteen feet above the datum plane, and five feet below the bed of the river. Although the Pequest above the Steam-mill Bridge, after the bed below the bridge is cut down to the grade, will have *fall* enough, yet the present channel is entirely too *shallow* to carry off the water. For this reason it will be necessary to cut it down to the grade line, which is from two to five feet below the present bed. The river will then be deep enough to carry off the water without overflowing its banks, and still have a fall of one foot per mile. As the bottom of the river along this meadow is mostly mud and sand-bars, it will not be difficult to make it two or three feet deeper. From Long Bridge up to Adams' Bridge, the rise is five feet; from Long Bridge to Trout Brook Bridge, it is six feet. A fall of three feet per mile can be obtained here, and the channel dug deep enough to keep the land dry.

PROPOSED CUT-OFF.

The profile of the "cut" from the Pequest, one hundred and ten yards above the Steam-mill Bridge, through by Danville Church to the Pequest at first bench, and also that of the branch cut striking the Pequest four hundred yards above first bench, represents the heights along the surface of the ground above the same datum plane that the heights on the river are referred to.

The grade, represented in the profile, leaves the Pequest at a point one hundred and ten yards above the Steam-mill

Bridge, and eight and one-third feet above the datum plane, —which, it will be seen, is in the grade line drawn in the profile of the river—and, with a fall of two feet per mile, reaches the Pequest at first bench five and six-tenths feet above the datum plane; or, by the branch cut, reaches the river five and ninth-tenths feet above the datum plane. Both of these routes were leveled for the purpose of ascertaining which would be the most favorable one for the "cut" that the citizens of Danville and Vienna have talked of for some time as being more favorable to the draining of the Great Meadows than the present channel of the river.

By reference to the profiles it will be seen that the cut to the first bench will be fifty six feet deep at the highest point, and the other forty-nine feet; and that the latter is shorter than the former by seven hundred and fifteen feet.

With a cross section of thirty feet bottom, and a slope of three base to two rise the excavation in these cuts down to the grade line will be as follows:

	Cubic Yards.
From one hundred and ten yards above Steam-mill Bridge to junction of cuts	77,365
From junction of cuts to first bench	232,511
" " " river four hundred yards above first bench	187,296
Total excavation from one hundred and ten yards above Steam-mill Bridge to first bench	309,876
Total excavation from one hundred and ten yards above Steam-mill Bridge to point four hundred yards above first bench	264,661

With the same cross section of thirty feet base, the amount of excavation in the present channel of the river between first bench and the point one hundred and ten yards above Steam-mill Bridge will be:

	Cubic Yards.
Excavation in rock on the three reefs	13,363
" " loose earth	10,641
Total excavation in rock and and loose earth between first bench and one hundred and ten yards above Steam-mill Bridge	24,204

This will give the channel from Steam-mill Bridge down, a fall of one foot per mile, while the amount of excavation in the proposed "cut" from the same point one hundred and ten yards above Steam-mill Bridge through by Danville Church to the Pequest at the upper point four hundred yards above first bench will be 264,661 cubic yards, or more than ten times the amount in the river. And I do not think there is any reason to conclude that, in either cut, there will be found less rock than in the river. Yet the "cut" will drain the swamp no deeper than the river in its present channel, if the latter be cut down to the grade line. It would seem then from the above that the cheapest plan to drain the Great Meadows, and the one that will make the drainage thorough, is to cut down the present river bed to the grade represented in the profile.

By reference to the *map* of the Great Meadows, it will be seen that very much cutting can be saved by straightening the Pequest, in many places, between the Steam-mill Bridge and Long Bridge. The area of the swamp is about 5500 acres. The soil is a black muck. The figures on the map denote the depth of the muck down to a sand or gravel bottom. When properly drained, the Great Meadows will be far the most valuable land in that section of country.

The chief expense of this improvement will be in cutting through the rocks at the reefs which may cost $20,000.

APPENDIX C.

Publications of the New Jersey Geological Survey.

Geology of New Jersey, 899 pages large octavo, illustrated by 108 photolithographic engravings and woodcuts, and six mine maps; and accompanied by a portfolio containing the following maps, in sheets:

1. Azoic and Paleozoic Formations, including the Iron-ore and limestone districts; colored; scale 2 miles to an inch:
2. Triassic Formation, including the Red Sandstone and Trap-rocks of Central New Jersey; colored; scale, 2 miles to an inch:
3. Cretaceous Formation, including the Greensand Marl Beds; colored; scale, 2 miles to an inch:
4. Tertiary and Recent Formations of Southern New Jersey; colored; scale, 2 miles to an inch:
5. Map of a Group of Iron Mines in Morris county; printed in two colors; scale, 3 inches to 1 mile:
6. Map of the Ringwood Iron Mines; printed in two colors; scale, 8 inches to 1 mile:
7. Map of the Oxford Furnace Iron-ore Veins; colored; scale, 8 inches to 1 mile:
8. Map of the Zinc Mines, Sussex county; colored; scale, 8 inches to 1 mile:

Price of the book and portfolio of maps, $6.50

Geology of New Jersey, as above, without portfolio of maps, but containing a folded and colored map of the State, on a scale of 5 miles to 1 inch. Price $4.00.

Single copies of either of the above maps, colored and in sheets, 50 cents.

Geological Map of New Jersey, on a scale of 2 miles to one inch; colored and mounted on rollers. It gives the Geology of the State the same as Maps 1, 2, 3, 4, in the portfolio, and is essentially these combined in one map. Size 5½ by 7½ feet. Price $8.00 per copy.

The prices are fixed to merely cover the cost of paper, printing and binding; the expenses of the Survey and preparing book and engravings being paid by the State.

These publications can be had from Prof. Geo. H. Cook, State Geologist, New Brunswick, on remitting the price, or through the booksellers.

The books are also kept for sale at these prices by William T. Nicholson, of Trenton; Sampson & Morgan, of New Brunswick; M. R. Dennis & Co., of Newark, and D. Van Nostrand, of New York city.

The work is in the following public libraries, where it can be consulted:

In all the State Libraries; in some other of the large public libraries in different parts of the United States, and in all the public libraries in New Jersey and in the adjacent cities of New York and Philadelphia. It is also in the offices of most of the County Clerks.

ANNUAL REPORT

OF THE

STATE GEOLOGIST

OF

NEW-JERSEY,

FOR THE YEAR 1871.

NEW-BRUNSWICK, N. J.:
FREDONIAN STEAM BOOK AND JOB PRINTING HOUSE.
1872.

ANNUAL REPORT

OF THE

STATE GEOLOGIST

OF

NEW-JERSEY,

FOR THE YEAR 1871.

NEW-BRUNSWICK, N. J.:
FREDONIAN STEAM BOOK AND JOB PRINTING HOUSE.
1872.

GEOLOGICAL SURVEY OF NEW-JERSEY.

BOARD OF MANAGERS.

His Excellency, Theodore F. Randolph, Governor, and *ex-officio* President of the Board.

Hon. Andrew K. Hay, Winslow, Charles E. Elmer, Esq., Bridgeton,	*First Cong.* ***Dist.***
Hon. William Parry, Cinnaminson, Hon. Henry S. Little, Matawan,	*Second Cong.* ***Dist.***
Selden T. Scranton, Esq., Oxford, Henry Aitkin, Esq., Elizabeth,	*Third Cong.* ***Dist.***
Hon. Andrew B. Cobb, Parsippany, Abram S. Hewitt, Esq., Ringwood,	*Fourth Cong.* ***Dist.***
William M. Force, Esq., Newark, Thomas T. Kinney, Esq., Newark,	*Fifth Cong.* ***Dist.***

STATE GEOLOGIST:

GEO. H. COOK, New-Brunswick.

To His Excellency, Theodore F. Randolph, *Governor of the State of New-Jersey, and ex-officio President of the Board of Managers of the State Geological Survey.*

Sir :—I have the honor herewith to submit my annual report, on the Geological Survey of the State, for the year 1871.

With much respect,

Your obedient servant,

GEO. H. COOK,

State Geologist.

Rutgers College.
New-Brunswick, Dec. 26, 1871.

REPORT.

THE operations of the Survey have been prosecuted during the past year, both in the field, and in the laboratory and office. The results of the work will appear, in part, in the following pages; while another part consisting of partially finished work upon the iron mines, and on the soils of the State, is reserved until it can be completed, and published in a separate report.

PERSONS EMPLOYED.

The following persons have been engaged in the work during some portion of the year.

PROF. JOHN C. SMOCK, *Assistant Geologist,* has been occupied with investigations on the rocks of the iron-ore region, in examining mines, the methods of finding and opening them, &c. He began work in June, and has been employed for about two-thirds of the time since.

EDWIN H. BOGARDUS, *Chemist,* has been at his duties in the laboratory all the year, except a few weeks, in which he was in the field collecting specimens of rocks, for examination. His work has consisted of the analysis of ores, rocks, soils, and fer-fertilizers.

PROF. EDWARD A. BOWSER, *Civil Engineer,* has been employed a portion of the year in surveying the Drowned Lands on the Wallkill in Sussex Co., and preparing his report, map and profiles of the work. He has also surveyed and mapped the lands liable to overflow on the Passaic, Whippany, and Rockaway Rivers, from Little Falls on the Passaic to Chatham on the Passaic, to Whippany and Madison on the Whippany, and to Rockaway Neck on the Rockaway. He has also surveyed the Great Meadows in Warren County, which are liable to overflow with freshets in the Pequest. The two last mentioned surveys have been made in obedience to the "Act to provide for the Drainage of Lands, approved March 8th, 1871," which puts the direction of works of drainage under the charge of the Board of Managers of the Geological Survey, and requires them to make examinations and surveys, on the petition of owners of the wet and flowed lands. He has been employed about three months.

Geo. W. Howell, *Civil Engineer*, has surveyed and mapped the wet and flowed lands on the Passaic and Dead Rivers, from Chatham to Millington on the Passaic, and to Liberty Corner on Dead River. He has also made the maps and profiles for the drainage of the Great Meadows, on the Pequest. He was employed for about one month.

PROPOSED PLAN OF WORK FOR THE COMING YEAR.

The time for which provision has been made for the expenses of this survey ends next year. The special works upon drainage, on our natural fertilizers, on soils and agriculture, and on our iron ores and mining, which were proposed at the beginning, can be closed in that time. The surveys and reports upon drainage have probably been made as full as is required at the state expense, and the present report with those of 1869 and 1870 will have put upon record the facts regarding the most important of these works. The report upon iron ores and mining is well advanced—most of the mines have been re-examined, collections and studies of the rock structure of the region have been made, an account and explanation of the mode of searching for iron-ore veins has been prepared, and the work of completing the report is provided for. It is proposed to print and distribute this report separately.

The report upon soils and fertilizers is so far advanced that it can be published in the course of the year. Such a work can never be complete, as long as agriculture is improving, and we have lands to bring into cultivation, and farming resources to develop.

The progress of the survey continually shows new fields in which the fostering care of the State can profitably be employed to aid individual effort in developing our mineral, manufacturing and agricultural wealth. A better map of our mining districts is much needed. One that would exhibit the topography of the country, show the inequalities of the surface, the mountains, hills, ridges, valleys, &c., would be of great service to the iron industry of the state. It would give direction and accuracy to studies on the geological structure of the region, to mining explorations, to manufacturing enterprises using water-power, and to agriculture. Such a map was made of some sixty or seventy square miles about Dover. It was first drawn on a scale of six inches to a mile, but was afterwards engraved on a scale of three inches. It is much liked by all who have had occasion to use it, and if a similar one could be made of the whole iron-ore region of the state it would be useful, and meet a want which is felt by many. The United States Coast Survey stations would furnish a basis upon which the triangulation could be extended so as to include any desired area in its net work, and give the required accuracy without resort to expensive measurements of a new base line, or to tedious astronomical observations to determine latitudes and longitudes. The construction of such a map involves both money and time. I would respectfully submit whether it is not expedient to inaugurate such a work the coming year, laying out the plan, ascertaining carefully the amount and kind of work to be done, and making proper estimates of its annual cost, the time required for its completion, and the expense of publication.

PUBLICATIONS OF THE SURVEY.

There is a moderate call for the "Geology of New-Jersey," and also for the maps. They have been supplied to all libraries within the state, as far as these have been ascertained. The copies of the Annual Report have been much called for, and they have been distributed more extensively than ever before. The letters of inquiry regarding geological, mineral, agricultural, and other scientific and industrial matters, are very numerous, and occupy much time in answering. As far as possible, these have been attended to.

There have been two applications to the Board during the year for permission to use the geographic, topographic and other material collected by the Survey. The Board, considering that the interests of the state were best subserved by favoring enterprises which have for their object the publication of our resources, passed the following resolution. "That the State Geologist be authorized to allow the publishers of maps and geographical books to make such use of the material under his control, as will in his judgement tend to diffuse a knowledge of the resources of the state, provided that no exclusive privilege be granted to any publisher; and the maps and printed matter in such publications shall first be submitted to the State Geologist, and be approved by him before publication." Under this authority, Messrs. Beers, Comstock and Kline, of Newark, map publishers, have been allowed the use of material from the Survey, in preparing a new atlas of the state. And it is fair to presume that our citizens will get a better atlas for the price paid than they could have got without the use of this material.

DRAINAGE LAW.

At the last session of the Legislature, a law was passed entitled "An act to provide for the drainage of lands,"* in which "the Board of Managers of the Geological Survey, on the application of at least five owners of separate lots of land included in any tract of land in this state, which is subject to overflow from freshets, or which is usually in a low, marshy, boggy or wet condition, shall be and hereby are authorized and empowered to examine such tract, and if they shall deem it for the interest of the public, and of the land-owners to be affected thereby, they are further authorized, from time to time, to make surveys of any such tract or tracts of land, and to decide upon and adopt a system of drainage for draining the same, and to cause maps of the same, together with the plans of drainage by them adopted, to be made; and for this purpose they shall be authorized to call in the assistance of the State Geologist, and such other persons as they may deem expedient; and when they shall have completed their said surveys, maps and plans, they shall make a written or printed report of the same to the Supreme Court of this state; and thereupon it shall be the duty of the said Court, at the same or next stated term thereof, or as soon as can conveniently be done, upon reasonable notice given to that effect, and published in a newspaper circulating in the county where such tract of lowlands is situate, to appoint three commissioners (not interested in the lands to be drained) to superintend and carry out the drainage of any particular tract or tracts aforesaid, whose duty it shall be to carry out and execute the system of drainage which may thus have been adopted and reported by the said Board of Managers, in reference to said particular tract or tracts; provided, that if, at the time fixed for such appointment of commissioners, it shall appear to the Court by the written remonstrance of the owners of a majority of the said low and wet lands, duly authenticated by affidavit, that they are opposed to the drainage thereof at the common expense, then the said Court shall not appoint such commissioners as is directed in this section." Other sections prescribe the mode of proceeding to execute the work, to assess and collect money to pay the expense, to compensate for damages, and to perform all acts necessary to carry out the contemplated work of drainage.

---

*Laws of New-Jersey, 1871; Chap. 132, p. 25.

Under this act the "owners of lands subject to overflow, bordering the Passaic River between Chatham and Little Falls," applied to the Board of Managers to examine said lands, determine upon a system of drainage for the same, and to take such legal steps as may be necessary to effect the object desired with the least delay. A meeting of the managers was held, a committee appointed to examine the lands, and if judged expedient to prepare maps and plans for the drainage, and report to the Board. The committee made the examination, directed surveys, maps and plans of the proposed drainage to be prepared, and when these were done, submitted them to the Board with their report. Their report was accepted, and ordered to be presented to the Supreme Court for the appointment of commissioners. The report and maps were presented to the Supreme Court in June last, and notice of the application was published in the newspapers of Essex, Morris and Passaic counties for eight weeks preceding the November term of the Court. The commissioners have not yet been appointed.

A like application was made by the owners of wet and overflowed lands on the Passaic River, between Chatham and Millington, which was received by the Board of Managers, and acted upon in the same manner with the preceding. The maps plans and report were presented to the Supreme Court in June, and public notice of the application was given for two months preceding the November term of the Supreme Court, in the newspapers of Essex, Morris, Somerset and Union. The result of the application is not yet announced.

An application has been made to the Board by the owners of wet and boggy land in the Great Meadows, on the Pequest, in Warren County, for the examination, and if judged proper, for a plan of drainage of said meadows ; and that the necessary action be taken to carry out the plan under the Drainage Law. The map, plan and report upon the same are before the Board for their final action this day.*

The execution of these works of drainage would reclaim a large amount of rich and valuable land, would do much to drive away chills and fever, which are now quite too common, and would greatly help the attractiveness of important parts of the State. At the same time, the pecuniary benefits arising from the increased value of the lands, will be secured to the landowners. The plans presented by the Board, as well as the provisions of the law, are arranged so as to keep down the expenses as low as is consistent with the proper and thorough execution of the work; and the powers of the commissioners will enable them to carry out the work without burdensome taxation of the land-holders.

---

*The map and plan are filed in the Office of the Clerk of the Supreme Court, and the Board ordered the application to be made at the February Term.

DROWNED LANDS OF THE WALLKILL.

The valley of the Wallkill, from Hamburg in Sussex County, almost to Goshen in Orange County, New York, is largely occupied by a tract of swamp and marshy grounds, known as the Drowned Lands. The obstruction which stops the flow of the stream and causes these lands to form, is in the State of New York, and the largest body of swamp and marsh is in that State; but the portion in our state is a large one—not less than ten thousand acres[*] in Sussex County being subject to overflow whenever there is a freshet in the Wallkill, and the current in the stream is so sluggish that the water in a single freshet remains for many days upon these lands, effectually preventing cultivation, and rendering the natural and wild growth almost worthless. The importance of reclaiming these lands has induced me to have them surveyed, and proper levels taken so as to find out the nature of the obstructions to the flow of the stream, their location and extent.

Prof. Edward A. Bowser has made the examinations, and he finds the chief obstruction to be in a heavy deposit of drift-earth and boulders, and perhaps some slate rock in the lower part, which fills the valley at Denton and Hampton, three miles and a half west of Goshen, in Orange County. The Wallkill found a passage over this bank, but had not the force to wear it away, and the water remained dammed up in a pond, filling the valley for twenty miles south, and in some places spreading out to a width of four miles. In passing over this bank the water had a fall of twenty-four feet in a distance of two miles. At an early period, dams were built at Hampton to utilize this fall, and two mills were erected. The property in these mills has operated as a hindrance to any efforts for lowering the bed of the stream, or carrying out any plan for draining the Drowned Lands. About forty years ago a very vigorous effort was made to improve the drainage, and a ditch or *canal* was cut across from the stream at the lower end of the Drowned Lands, the location of which was about a half mile east of the old channel, and entered the original bed three miles below, shortening the distance about a half mile. The water all runs in the new channel now, and its surface at the lower end of the Drowned Lands is considerably lower than the bottom of the old bed of the stream. This has done much to improve these lands, but it is by no means all that is needed. They are still flooded after heavy rains, and the current of the stream is scarcely perceptible in thirty miles or more of its tortuous course. In the freshet on the first of September, 1871, the fall in the whole distance from Denton to Ogden's Bridge, which by the course of the stream is thirty-five miles, was only seven and a half feet.

---

[*] The whole area of these lands is 25,000 acres of which 15,600 acres are in Orange County.

It would be easy to deepen the canal seven or eight feet. A very moderate expense in cutting off bends in the stream would shorten its course several miles, and the removal of a few bars in the channel would give a uniform and lively current to the Wallkill through the whole length of the Drowned Lands.

New-Jersey is largely interested in having this improvement carried out. And I have no doubt that any active effort on the part of the owners of the flooded lands in Sussex, would meet a hearty response from those interested, in Orange County, and that together they could carry it to a thorough successful end.

The value of these lands where they have been successfully drained, can hardly be over estimated. In the vicinity of Chester, Orange County, a considerable tract is reclaimed and cultivated. Onions have been a specially successful crop ; a thousand dollars worth having, in many cases, been taken from a single acre of this black ground. Near Florida, in the same county, I saw a field of this kind, from which the owner assured me he had taken a hundred and fifty bushels of ears of corn per acre, for fifteen years in succession. Potatoes, also, yield enormous crops in this soil. For meadows and pasturage it is all admirably adapted. The carrying out of this work

LIBR

Hamburg

would change an unsightly waste into a field of rural beauty and riches.

The report of Prof. **Bowser**, with his map and profiles, is presented here.

Prof. Bowser's Report of the Levels and Soundings taken on the Wallkill River and its branches, the Pochunk and Wawayanda Creeks, in Sussex County, N. J., and Orange County, N. Y.

A bench, called "first bench," was made on a large maple tree, on the right bank of the Wallkill, and on the left bank of the "canal," at their junction, or "outlet" of the canal, about 800 yards below Hampton. The datum plane was assumed 10 feet under this bench. A line of levels was run from this bench up the Wallkill to Lawrence's Bridge, distant in a right line about 20 miles, and about 37 miles by following the channel; and also up the Pochunk Creek to the second bridge above the mouth of the Wawayanda Creek; and up the Wawayanda to the second bridge; and benches were located at all the bridges and at intermediate points. The heights along the surface of the river were determined by leveling from these benches. The heights along the bottom were determined by sounding in the channel, and subtracting the depths from the heights of the surface. The heights of the points, both along the surface and the bottom of the river, were measured from the datum plane 10 feet beneath the first bench.

By examining the profile, it will be seen that the bed of the river, from the first bench up to the lower end of the Drowned

Lands, has a rise of 24.6 feet, while the rise from the first bench to the upper end of the canal—inlet of the canal—is but 14 8-10 feet, making the bed of the river at the latter place 9 8-10 feet *lower* than it is at the lower end of the Drowned Lands in the old channel of the river.

The bed of the river at the lower dam is 10 7-10 feet, and at the upper dam, just below the railroad bridge, it is 14½ feet higher than it is at the first bench. Although the bed of the river from the second dam to the lower end of the Drowned Lands rises 10 1-10 feet, yet owing to the *fall* of 9 8-10 feet from the latter place to the inlet, the rise from the second dam to the inlet is only 8-10 of a foot, and from the first dam to the inlet it is only 4 1-10 feet. The top of the lower dam is 4-10 of a foot, and that of the second dam 6 7-10 feet higher than the bed of the river at the inlet.

The rise in the bed of the river, from the inlet to Pellett's Island bridge, is 3½ feet, while from the latter up to Willcox's bridge, distant 12½ miles by the river, the rise is only 1 2-10 feet. The bed of the river at Black Walnut Island is 3½ feet *higher* than it is at Willcox's bridge. The bed of the river at Kimberg Point bridge is 4 3-10 feet *lower* than at Willcox's bridge, and 7 8-10 feet *lower* than at Black Walnut Island, while just above the State Line, it is 3 7-10 feet higher than at Willcox's, or on a level with the bed at Black Walnut Island. The bed at Bessett's bridge, distant ten miles from Willcox's by the channel, is on a level with that at Willcox's bridge, or 3 7-10 feet *lower* than at Black Walnut Island, while from Bessett's to Ogden's bridge, distant nine miles following the channel, owing to the increased shallowness of the river, the rise is 11 7-10 feet, making a rise of 8 feet from Black Walnut Island to Ogden's bridge, or 16 1-5 feet from the inlet to Ogden's. The rise from Ogden's to Lawrence's bridge is 2 7-10 feet.

The profile of the Pochunk Creek shows that its bed at the mouth is 7 4-5 feet *lower* than the bed of the Wallkill at Black Walnut Island, and that its bed at the Neck bridge, Garner's Island bridge and the Pochunk bridge is 1 4-5 feet, 9-10 feet, and 3 1-5 feet, respectively, higher than the bed of the Wall-

LIBRARY
Leland Stanford, Jr.
UNIVERSITY

La

to

14

9 8

La

th

hi

fro

ris

la

in

in

4-

th

I

b

f

h

a

k

v

kill at Black Walnut Island. The rise in the bed, from the Pochunk bridge to Martin's bridge, is 6 7-10 feet, from Martin's to the first bridge above the mouth of the Wawayanda Creek it is 4 1-5 feet, and from the latter bridge to the second bridge above the mouth of the Wawayanda the rise is 2 9-10 feet.

The rise of the bed on the Wawayanda Creek, from the mouth to Edsall's bridge is 3 3-10 feet, and from Edsall's to the second bridge the rise is 5 7-10 feet.

The profile of the Canal shows that the rise of its bed is much more uniform than the rise of the bed in the old channel. The rise in the bed from thfirst bench to the railroad bridge is 2 1-5 feet; from the railroad bridge to Wheeler's bridge it is 8 3-10 feet; and from Wheeler's bridge to the inlet the rise is 4 3-10 feet, and very uniform, excepting a reef about 600 yards above Wheeler's bridge, which is 2 7-10 feet *higher* than the bed at the inlet. The top of the old dam, 800 yards below Wheeler's bridge, is 28 3-10 feet above the bed of the river at the first bench, or 3 7-10 feet higher than the bed of the old channel at the lower end of the Drowned Lands.

The rise of the water surface on August 16, 1871, from the inlet to Willcox's bridge, 12½ miles, was 6½ feet, and from Willcox's bridge to Ogden's bridge, 9 miles, it was 3 3-10 feet, making a rise of 9 4-5 feet from the inlet to Ogden's bridge, distant 21½ miles. Though it was a very dry time, the water from Black Walnut Island up to Ogden's was on a level with the top of the ground. On September 1st, when there had been considerable rain, the rise of the water surface from the inlet to Willcox's bridge was 7 1-5 feet. Much of this rise was owing to the obstruction at Black Walnut Island, where the water runs over a point of the upland. The surface rise from Willcox's to Ogden's was 1½ feet, and from Ogden's to Lawrence's it was 3 7-10 feet. The water during this week was from 2 to 5 feet deep on the "Drowned Lands." The rise of the water surface, on the Pochunk, during this time, from its mouth to the Pochunk bridge, was 1 foot; from the Pochunk bridge to Martin's bridge it was 3 7-10 feet; and from Martin's to the second bridge above the mouth of the Wawayanda it was 5 1-10 feet, the water standing 3 and 4 feet deep on the meadow. The rise of the water surface, on the Wawayanda, during the same time, from its mouth to Edsall's bridge was 3 3-10 feet, and from Edsall's to the second bridge on the Wawayanda it was 5 7-10 feet. The country from the lower end of the Drowned Lands to Lawrence's bridge, and on the Pochunk to the second bridge above the mouth of the Wawayanda, was covered with water, in many places 5 feet deep. This water remained upon the land over two weeks.

A fall of 8 inches per mile would give the Wallkill a velocity of about 1½ feet per second. If the river from Ogden's bridge down to the first bench be shortened to 30 miles, which can very easily be done by cutting off some bends, 8 inches per mile would give a fall of 20 feet from Ogden's down to the first bench. Had this been the fall of the Wallkill in the first week of September, and the grade at Ogden's bridge 4 feet below its present bed, which is now entirely too shallow, the water could scarcely have remained above its banks for more than two days.

The grade line on the profile represents this new bed. It begins at Ogden's bridge, 4 feet below the present bed, and falls 6 9-10 inches per mile, following the present channel as it is represented in the profile; or, if the channel from Ogden's bridge to the first bench be reduced to 30 miles, the grade will be 8 inches per mile, giving in either case a fall of 20 feet from Ogden's bridge down to the first bench.

By examining the profile, it will be seen where the grade runs *below* the present bed, and where it runs *above* it. At Bessett's bridge it runs *above* the bed, while 400 yards below the bridge it runs *under* it 6 feet. At Kimberg's Point bridge the grade is again above the bed, while 500 yards below, it is 8 feet beneath it. At Stewart's landing the grade is 10 feet beneath the bed. At Willcox's bridge it is 3½ feet beneath the bed. At lower end of Willcox's Island it is 10½ feet beneath the bed. At the mouth of the Pochunk it is 2½ feet beneath the bed. At the upper end of Black Walnut Island it is 9½. feet beneath the bed. At the lower end, 7 feet beneath. It reaches Pellett's Island bridge 9 feet under the bed, and the inlet of the canal 6 feet under the bed. Following down the old channel we see that the grade reaches the lower end of the Drowned Lands 16½ feet beneath the present bed, the railroad bridge 11½ feet, the second dam 7 feet, and the first dam 3½ feet beneath the present bed. It reaches the first bench 7 4-5 feet above the present bed. Following the canal, whose bed is much more uniform, the grade reaches the reef 9 feet, Wheeler's bridge 3 feet, and the dam below Wheeler's bridge 1 foot below the present bed of the canal. The cutting in the old channel, the profile shows, greatly exceeds the cutting in the canal.

The Pochunk Creek, being a smaller stream, requires a greater fall. At the second bridge above the mouth of the Wawayanda Creek, the Pochunk at present is entirely too shallow. Its bed here should be cut down 6 feet, leaving a fall of 19½ feet from this bridge to the mouth of the Pochunk, distant 11 miles, or 1 4-5 feet per mile. This grade, as the profile shows, reaches the first bridge above the mouth of the Wawayanda 5½ feet, Martin's bridge 4 feet, the Pochunk bridge 4½ feet, Garner's Island bridge 5 feet, and the Neck bridge 7 feet below the present bed of the channel. It reaches the mouth of the Pochunk 2½ feet beneath the present bed, or on a level with the grade on the Wallkill River.

The Map accompanying this report shows the extent of the Drowned Lands, the exceedingly crooked channel of the Wallkill and the Pochunk, and the nature of the surface material, whether black muck alone or mixed with mud (blue clay). The figures on the map denote the depth in feet of the surface material down to the hard bottom, which is sand or gravel. The material for drawing the map of that part of the Drowned Lands which lies in Orange County, was obtained from A. S. Murray, Esq., of Goshen, who very kindly lent me a map of these lands, that was made several years ago, when there was an attempt made to drain them. The material for making the map of that portion of the Drowned Lands that lies in Sussex County was obtained by traversing the shore line during high water. The depth of the surface material was ascertained by running an iron rod down to the solid bottom. Wherever it was muck alone, the ground was very soft, the rod running down easily. Where there was considerable clay—which was generally near the banks of the Wallkill and the Pochunk, and especially near streams running into these channels—the ground was very firm, the rod running down with difficulty. The nature of the surface material in Sussex County, and also of that portion of the land in Orange County that produces only wild grass, is similar to that in Orange County that is under cultivation, and that produces as fine crops as are to be seen anywhere in the country. There is this difference, however: the surface material in Sussex County, above Bessett's bridge, is not so deep as it is lower down in Orange County. The number of acres of Drowned Lands in Orange County, (by Murray's Map), 15,579; the number of acres in Sussex, 10,000; total number of acres of the Drowned Lands in Orange County and in Sussex, on the Wallkill River, and the Pochunk and Wawayanda Creek, 25,579.

As the amount of cutting in the canal will be far less than in the old channel, it will be economy to carry the water down the canal, where it is running at present. If one of the mills below Hampton could be saved, it would be very desirable to carry the water down the old channel. But as the grade runs 3½ feet *beneath* the bed of the river at the lower dam, there will be no possibility of saving a mill. It seems, therefore, that there can be no object in carrying the water down the old channel, when it can be taken down the canal with *far less expense.*

AGRICULTURE AND POPULATION.

The United States census of 1870, though only partially published as yet, gives some information of much interest to Jerseymen. The population of the United States and of the State of New-Jersey is given in the following table, for every ten years, beginning with 1790. The table also shows the percentage of increase for each ten years:

	Population of United States.	Percentage of increase.	Population of N. Jersey.	Percentage of increase.
1790......	3,929,827		184,193	
1800......	5,305,937	35.02	211,949	15.10
1810......	7,239,814	36.45	245,555	15.86
1820......	9,638,191	33.13	277,426	13.04
1830......	12,866,020	33.49	320,823	15.58
1840......	17,069,453	32.67	373,306	16.36
1850......	23,191,876	35.87	489,555	31.14
1860......	31,443,321	35.58	672,035	37.27
1870......	38,998,753	24.03	906,096	34.83

It will be seen that there has been a very uniform increase in the population of the United States up to the last ten years, when the destructive civil war interfered to check our rapid growth, and diminished the aggregate by probably three million persons.

Our own state has had a much more irregular growth. For fifty years after 1790, the percentage of increase was less than half that of the whole country, owing probably to the large emigration to the newer States. Since then, however, the growth has been much more rapid—for twenty years about equal to that of the whole country, and for the last ten years considerably greater. Our growth was checked by the war, the state census of 1865 showing a population of 773,700, and an increase of 15.14 per cent. in five years, while the percentage of increase for the last five years is 19.70, a more rapid growth than it has ever had before.

The increase of population is not uniform throughout all parts of the state, as appears in the following list of counties with the population of each for every ten years from 1790 to 1870, with the ratio of increase for the last ten years. The arrangement of counties is geographical, so as to bring those counties which have been set off since 1790 next those from which they were taken :

POPULATION OF NEW-JERSEY AT DIFFERENT PERIODS.

COUNTIES.	1790.	1800.	1810.	1820.	1830.	1840.	1850.	1860.	1870.	Pr cent. increase past 10 years.
Bergen	12,601	15,956	16,603	18,178	22,412	13,223	14,725	21,618	30,122	39.34
Passaic	-------	-------	-------	-------	-------	16,734	22,569	29,013	46,416	59.98
Hudson	-------	-------	-------	-------	-------	9,483	21,822	62,717	129,067	105.79
Essex	17,785	22,269	25,984	30,793	41,911	44,621	73,950	98,877	143,839	45.47
Union	-------	-------	-------	-------	-------	-------	-------	27,780	41,859	50.68
Morris	16,216	17,750	21,828	21,368	23,666	25,844	30,158	34,677	43,137	24.40
Sussex	19.500	22,534	25,549	32,752	20,346	21,770	22,989	23,846	23,168	—2.84
Warren	-------	-------	-------	-------	18,627	20,366	22,358	28,433	34,336	20.76
Hunterdon	20,153	21,261	24,556	28,604	31,060	24,787	28,990	33,654	36,963	9.83
Mercer	-------	-------	-------	-------	-------	21,502	27,992	37,419	46,386	23.96
Somerset	12,296	12,815	14,725	16,506	17,689	17,455	19,692	22,057	23,510	6.58
Middlesex	15,956	17,890	20,381	21,470	23,157	21,893	28,635	34,812	45,029	29.35
Monmouth	16,918	19,872	22,150	25,038	29,233	32,909	30,313	39,346	46,195	17.41
Ocean	-------	-------	-------	-------	-------	-------	10,032	11,176	13,628	21.94
Burlington	18,095	21,524	24,972	28,882	31,107	32,831	43,203	49,730	53,639	7.86
Camden	-------	-------	-------	-------	-------	-------	25,422	34,457	46,193	34.06
Gloucester	13,363	16,115	19,744	23,089	28,431	25,438	14,655	18,444	21,562	16.90
Atlantic	-------	-------	-------	-------	-------	8,726	8,961	11,786	14,093	19.58
Salem	10,437	11,371	12,761	14,022	14,155	16,024	19,467	22,458	23,940	6.60
Cumberland	8,248	9,529	12,670	12,668	14,093	14,374	17,189	22,605	34,665	53.35
Cape May	2,571	3,066	3,632	4,265	4,936	5,324	6,433	7,130	8,349	17.09
Total	184,193	211,949	245,555	277,426	320,823	373,306	489,555	672,035	906,096	34.83

The chief increase in population has been in the cities and towns near New York, and consists largely of manufacturers, artisans, and persons doing business in that city. There is, however, a large addition of persons in easy circumstances who have come here to get the climatic, social and educational advantages of New-Jersey. It is worthy of remark that the counties which are purely agricultural, and are well improved throughout, have increased very little in the last ten years. Sussex, our best dairy county, has lost more than two per cent. Salem and Somerset, models of thrifty and productive farming districts, have gained but little more than six per cent.; Burlington and Hunterdon, our largest and wealthiest farming counties, only about eight and ten per cent. respectively. And of several others the increase is in the towns and not in the country. In fact, wherever the land is cleared and in good cultivation, it needs, with the modern implements, fewer hands to till the soil than it did forty years ago. In many sections this loss of population is very evident, at the same time that the farms are made to produce double, and in many cases four times as much as they formerly did.

There has been a considerable increase in the population of those counties which contain a large area of uncleared land. The wants of our first settlers required that they should clear and till land that would produce crops at once, and without manure; and such were the only lands cultivated in the early settlement of our State. All lands which did not possess this degree of available fertility were considered to be barren and valueless. A large area in New-Jersey especially in the southeast parts, came under this condemnation, and were held in disrepute till very recently. In the counties of Cape May, Cumberland, Salem, Gloucester, Camden, Atlantic, Burlington, Ocean, Monmouth and Middlesex there were in 1860, 734,561 acres of land of this class, and still covered with a forest of oak and yellow pine. It is one of the discoveries of modern farming that such lands can be profitably tilled. And there has been a considerable addition to our population in the new settlements in various parts of these counties; Cumberland and Atlantic in particular have increased largely in this way.

There is a continued advance in the Agriculture of the State. The area of improved land is growing larger, the land is better cultivated, more fertilizers are used, and larger and better paying crops are raised. This improvement is chiefly due to our location near New-York and Philadelphia, the best markets on our continent, and to our large manufacturing and mining population, which makes a ready home market for our products. But it is partly due to the real capabilities of the soil for raising crops ; which heretofore, and under an exhausting system of tillage, have been greatly underrated, but which, with an improved system of tillage, the judicious use of manures, and restorative crops, are proving their real worth. The statistics of farm lands and their value in our state will be more plainly exhibited by a comparison with those in the states of Connecticut, New-York, Pennsylvania and Delaware ; these states being nearest to us and to the great markets.

	Area in Acres.	Per centage of Land in Farms.
Connecticut	2,991,360	79
New-York	30,080,000	74
New-Jersey	4,848,832	62
Pennsylvania	29,440,000	61
Delaware	1,356,800	78

The prices of the farm lands per acre for the years 1850, 1860 and 1870, are given in the following table :

	1850.	1860.	1870
Connecticut	$30.50	$36.00	$52.54
New-York	29.00	38.00	57.36
New-Jersey	43.67	60.40	86.14
Pennsylvania	27.33	39.00	58.00
Delaware	19.75	31.00	44.39

From this, it appears that the value of our farm lands, by the acre, is much greater than in the neighboring states, and that it is still increasing as rapidly as ever.

In farm products, the comparison is equally favorable, as appears by the following table, which is also compiled from the census returns.

	Connecticut.	New-York.	New-Jersey.	Pennsylvania.	Delaware.
Bushels of Grain and Corn	3,206,773	77,751,088	15,985,688	97,992,934	4,473,625
" Potatoes	2,790,761	28,558,199	6,256,223	13,020,939	448,033
Value of Orchard Products	$535,954	8,347,417	1,295,282	4,208,094	1,226,893
" Market Garden Products	$599,718	3,432,354	2,978,250	1,810,016	198,075
" Slaughtered Animals	$4,881,858	28,225,720	6,982,162	28,412,903	997,403
Est'ed value of all Farm Products	$26,482,150	253,526,153	42,725,198	189,946,027	8,171,667
Value of all Live Stock	$17,545,038	175,882,712	21,443,463	115,647,075	4,257,323

The comparison between these different states can easily be made when it is considered that the land in farms in Connecticut is five-sixth as much as in New-Jersey ; in New-York, seven times as much ; in Pennsylvania. six times; and in Delaware, one-third as much.

A Comparison of the Agricultural Statistics of New-Jersey for Thirty Years.

FROM THE U. S. CENSUS REPORTS.

			1840.	1850.	1860.	1870.
ACRES OF LAND	Improved	Acres	....	1,767,991	1,944.441	1,976,474
	Woodland and other unimproved	"	....	984,955	1,039,084	1,013,037
PRESENT CASH VALUE	Of Farms	Dollars	....	120.237,511	180,250,338	257,523.376
	Of farming impl'nts & machin'y	"	....	4,425,503	5,746,567	7,887,991
Orchard Products		"	464,006	607,268	429,402	1,295,282
Produce of Market Gardens		"	249,613	475,242	1,547,995	2,978,250
Value of Animals Slaughtered or sold for Slaughter		"	....	2,638,555	4,120,276	6,982,162
Wool		Pounds	397,207	375.396	349,250	336,009
Butter		"	$1.328,032	9,478,210	10,714.447	8,266,023
Cheese		"	....	365,726	182,172	38,229
Milk Sold		Gallons	....	....	....	5,373,323
Value of all Live Stock		Dollars	....	10,679,291	16,134.693	21,443.463
Horses		Number	....	63,955	79,707	79,708
Mules and Asses		"	70,502	4,089	6,362	8,853
Milch Cows		"	....	118,736	138,818	133,331
Working Oxen		"	220,202	12,070	10,067	3,830
Other Cattle		"	....	80,455	89,909	60.327
Sheep		"	219,285	160,488	135,228	120,067
Swine		"	261,443	250,370	236,089	142,563
WHEAT	Spring	Bushels	....	....	....	2,099
	Winter	"	774.203	1,601.190	1,763 218	2,299,334
Rye		"	1,665,620	1,255.578	1,439,497	566,775
Indian Corn		"	4,361,975	8,759,704	9,723.336	8,745,384
Oats		"	3,083,524	3,378.063	4,539,132	4,009,830
Barley		"	12,501	6.492	24,915	8,283
Buckwheat		"	856,117	878,934	877.386	353,983
SEED	Clover	"	....	28,280	39.205	26,306
	Grass	"	....	63,051	85,408	72,401
Hay		Tons	334,861	435,950	508,726	521,975
Peas and Beans		Bushels	....	14,174	27,674	56,221
Irish Potatoes		"	2.072,069	3,207,236	4,171,690	4,705,439
Sweet Potatoes		"	....	508,015	1,034,832	1,550,784
Hops		Pounds	4,531	2.133	3,722	19,033
Flax		"	....	182.965	48,651	234.061
Flax Seed		Bushels	....	16,525,	3,241	6,095
Sorghum Molasses		Gallons	....	....	396	17,424
Tobacco		Pounds	1,922	310	149,485	40,871

A comparison of the census statistics of New-Jersey of 1840, 1850, 1860, and 1870, shows the direction in which its agriculture has developed. The area of cleared lands has increased but little. The value of farm lands has doubled.

The increased sales of farm produce, have been in orchard and market garden products, and in the value of animals slaughtered or sold for slaughter, There is a large increase in the quantity of potatoes raised. No statistics of other root crops have yet been collected, though turnips, in particular, are raised in large quantities for feeding stock.

More wheat is raised, and less rye than there was thirty years ago. The amount of Indian corn raised is double what it was in 1840.

In live stock it is remarkable that there is no increase in number, though there is a very large increase in value. Nothing shows this better than the sheep, which only number about half what they did in 1840, while the amount of wool has fallen off but little. There is a diminution in the number of working oxen, and an increase in the number of mules.

The changes are such as are called for by the peculiarities and advantages of our location. This will be more clearly seen, when the great development of our railroad system, and the consequent increase in marketing facilities, are considered.

According to the United States census of 1850 there were at that time 206 miles of railroad in operation in New-Jersey. In 1860 the number of miles was 560. The returns for 1870 are not at hand, but at the end of 1871 there were 1,110 miles in running order, an increase at the rate of 100 per cent. in eleven years.

At the beginning of the Geological Survey in 1854, and before the new settlements and improvements in the southern part of the state began, the total length of the railroad lines was 408 miles. Of this 78 miles only were in that half of the state south and southeast of the Camden and Amboy Railroad. In 1864, the date of the revival of the Survey, the length of railroad had increased to 704 miles, and that of the southern portion of the state to 305 miles. At the close of 1871 this length had still further increased to 405 miles. The ratio of railroad length to area is 1:6.82, *i. e.*, one mile of road to each 6.82 square miles of territory, so that if uniformly distributed no person in the state would be two miles from a railroad. And as it is, there are very few people in the state who cannot go to New-York or Philadelphia, transact business and return the same day.

In this condition of the agricultural resources of New-Jersey and its advantages for profitable development, there is a sufficient reason for the increased attention which is given to farming in all parts of the state.

The improvement so far has been mainly by enriching the land already cleared, and tilling and cultivating it more thoroughly. The marked success which has attended this is a warrant for bringing the still uncleared lands into cultivation. There are now almost a million acres of such lands in southern New-Jersey, which can be successfully brought into farms. Vineland, with its 10,000 inhabitants, Hammonton, Egg Harbor City, Bricksburg, Manchester and many smaller settlements, are on ground, that only ten or fifteen years ago were uncleared—and now they have become self-supporting—raising good crops of corn, wheat, clover, potatoes and other staple crops, and fruits in abundance, both for family and for market purposes.

Experience shows that this light land can be cheaply and easily cleared. It needs fertilizing for the first crop, but this is compensated by the cheaper tillage, warmer soil and fewer delays from either extremely wet or dry weather. The mildness and salubrity of the climate, too, are attractive to those who have experienced the rigors of a northern winter.

Immense deposits of peat are found in all parts, and the railroads give ready access to the marl beds. No better fertilizers than these can be found for supplementing the stores of the barn-yard, and there is no cheaper or more lasting fertilizer than the green-sand marl, which exists in inexhaustible quantities.

These uncleared lands constitute the largest body of undeveloped wealth in the state, and they offer a most inviting field for those who wish to get cheap farms and homes for themselves, and at the same time to retain the advantages which come from proximity to the great business centres of the country. Wild land can be got at from $5 to $25 an acre, according to its nearness to roads, railroads and settlements. The wood upon it is in many cases worth all the land costs. This is cut off, in the early summer, if possible, the brush is left scattered all over the ground, except a strip 10 or 15 feet wide all around the field. From this strip the brush and leaves are raked off and several furrows are plowed in it, so as to stop fire from getting into the adjoining lands. When dry the brush is fired on the windward side, and in a few minutes the fire sweeps over the whole ground, burning leaves, brush and everything, except some of the larger sticks. This costs not more than a dollar an acre. The ground is then plowed and harrowed, at a cost of $6, and dressed with 40 or 50 bushels of slaked lime per acre, at a cost of $5. The ground may then be sown with rye, and in the following spring with clover seed. The crop of rye will amount to 10 or 12 bushels an acre, and the clover will grow for two years, giving a crop of perhaps a ton an acre, each year.

Some farmers after plowing and liming the ground prefer to plant to potatoes in the spring, dressing them with 400 pounds of super-phosphate of lime, or 5 tons of marl, to the acre. An average crop of potatoes raised in this way is 50 bushels an acre. A crop of wheat or rye follows the potatoes. It is dressed with barn-yard manure, compost, or any good fertilizer that can be got. The quantity of wheat or rye will not be more than 10 or 12 bushels an acre. The clover sown in the wheat is a light crop, but it grows, and is the beginning of the improvement of the land.

After the land has been in clover two years, it is plowed up and planted to corn, of which it will yield a crop of 40 bushels an acre, without other fertilizer than the sod. Most of the stumps will plow out by this time. The corn may then be followed by oats or potatoes, and that crop by wheat, using such fertilizers as the farm will afford, and buying marl, super-phosphates, other purchased fertilizers, or gathering muck, marsh-mud, fish, sea-weed, &c., for composts, as the location will permit.

By the third rotation in this way, wheat may be brought to an average of 20 bushels an acre, corn to 70 bushels, and hay to 3 tons, while the cost of tillage is but little more than half what it is on heavy soils.

Iron Ores and Mining.

MAGNETIC IRON ORE.

In the Final Report, made in 1868, the "*list of mines of magnetic iron ore*" included 115 separate mines and groups of mines. The list as corrected in the autumn of 1871, contains 161 mines and localities, at which mining operations have been undertaken in their examination or further development—an increase of 46 during the past three years. This additional number is mainly due to quite recent explorations in Warren and Sussex Counties. In Morris County there has been little discovery outside of the large mines already in opertion. Within the limits of these there is, of course, much change and discovery as they are more and more extensively opened. But the number of localities at which ore is mined is less than it was a few years ago. The product is considerably greater, showing that the mines are more vigorously worked than at any previous period, and also that their capacity is not lessened as they get deeper. Several comparatively new openings have been given up, and some of the older mines appear to be worked out. The greater portion of the ore comes from about thirty mines and groups of mines. And these furnished nearly the same relative proportion of it three years ago. The remaining 131 localities consist of new openings, mines that are idle, and those that are yielding small amounts of ore. Many of them must be regarded as still in the nature of explorations—*undeveloped.* Of the mines not working, many are narrow *veins* and strings of ore ; in some there is too much rock, rendering the extraction of the ore unprofitable ; others are too far from easy and cheap communication, lines of railroad or canal ; a few are held by owners not in need of an additional supply of ore ; and a very few are idle for reasons known only to the business management.

In Hunterdon County nearly all of the iron ore mined comes from the Bethlehem and High Bridge mines. Some work in prospecting has been done near Lebanon and at various points on the Musconetcong Mountain, but the product of these discoveries has been inconsiderable.

In Warren County there have been several new openings made on the mountain range running northeast from Washington to the Sussex County line. Ore has been discovered in workable quantities at several points on the subordinate ridges of Jenny Jump Mountain. The most extensively worked of these new mines is that of the Pequest Mining Company, about two miles northeast of Oxford Furnace.

On Schooley's mountain, in Morris County, there are a few quite recent discoveries of ore, but they are not yet sufficiently explored to determine their probable value. Near Chester, three mines have been opened since 1868. Northeast of these, the mining operations, with few exceptions, are confined to the older localities.

In Sussex and Passaic counties the construction of the Midland Railroad has given a fresh impetus to searches for ore, and brought to light some outcrops that are quite encouraging. The completion of this road will no doubt lead to other discoveries, and to the further development of ore beds now known. Hitherto these have been almost valueless, in consequence of the cost of carting the ore several miles over rough roads to railroad and canal lines.

During the past year there have been some interesting discoveries of iron ore in the north eastern part of Somerset County—from two to three miles west of Bernardsville, but the diggings are still too limited in extent to speak with much certainty concerning them.

The detailed description of these localities is reserved for the final report on the iron ores of the state, to be published during the current year.

The product of the iron mines of the State for the year ending December 31st, 1871, may be approximately set down at 450,000 tons. The data for this estimate are as follows: the ore tonnage of the Delaware, Lackawanna and Western Railroad, Central Railroad of New-Jersey, Morris Canal; the statements of the managers at Ringwood, Oxford Furnace, Franklin Furnace, and the estimate for amounts mined at new openings, and mines whence the ore has not been shipped. The aggregate of the amounts carried from stations in New Jersey on the above mentioned lines is 411,661 tons. This latter sum includes some hematite, but the amount is scarcely large enough to warrant a deduction from the above estimated product. In the annual report for 1867, the product of the iron mines was estimated at 275,000 tons. In 1864, the estimate was 226,000 tons, so that there has been an increase of 100 per cent in the product of our iron mines since that date. Dr. Kitchell said, in 1855, that the mines might yield 100,000 tons for that year, or not one quarter of their present working.

Of this total, (450,000 tons,) more than four-fifths, or about 370,000 tons, come from Morris County, leaving but 80,000 tons for Sussex, Warren, Passaic and Hunterdon counties.

HEMATITE.

The mining of this ore of iron in New Jersey is limited to a few localities, of which the Pochuck and Edsall mines northeast of Hamburg, the Beattyestown mine, and that near Carpentersville, on the Delaware, are the most important. These have not been steadily worked since they were opened, so that the total product of hematite in the state is very small in comparison with that of the magnetic ore. It is occasionally found in small masses on or near the surface, but so far no very large deposits have been discovered outside of the above-mentioned mines. Small quantities have been obtained in pits dug in our limestone valleys. A recent discovery of interest was brought to the notice of the Survey by E. P. Potter, of Pottersville, Somerset County. The specimens sent by him came from German Valley, near the Hunterdon County line. The percentage of metallic iron in these was determined to be as follows :

No. 1.	No. 2.	No. 3.	No. 4.
54.88.	56.89.	40.45.	56.12.

The geological character of this valley is very similar to that of the Musconetcong Valley, and to that of the brown hematite localities of Eastern Pennsylvania. The probabilities in favor of the occurrence of workable deposits of such ore in this valley are strong enough to justify a careful and thorough examination of its whole surface, and its superficial beds. As ore is most generally found near the borders of the limestone outcrop, either between the gneiss (or grey rock) of the bounding ridges and the limestone, or between the latter rock and the overlying slate, searches should be confined more particularly to such lines of outcrop. Explorations should, however, extend over the whole breadth of these valleys, as it is sometimes found resting upon the limestone strata, covered by quite thick beds of ferruginous loam, clay or other earthy matter.

The total product of these mines for 1871, has been estimated by good authorities at 15,000 tons. But this is below their capacity, even as at present opened and worked.

Another interesting specimen sent to the Survey laboratory came from the bottom of the Beattystown mine. It was at first supposed to be an altered limestone belonging to the underlying rock strata, but a more careful examination showed it to be a carbonate of iron, mixed with some silicious matter. On analysis, it was found to contain 82.23 per cent. of carbonate of iron. The extent of this *ore* has not been ascertained, as it was first uncovered the day of the visit to this mine.

The increasing demand for hematites and the erection of new furnaces near some of these mines, will greatly enlarge their operations, and stimulate to discoveries in other localities.

ZINC ORE.

The zinc mines of the state have yielded about 22,000 tons of ore during the past year.

ARSENICAL ORE.

During the past season specimens of so-called silver ore have been extensively circulated at Hackettstown, and in the neighboring villages of Warren and Sussex counties, the localities whence they came being kept secret. A single lump of what was said to be the same as the "silver ore," was obtained from the ridges on the east side of the Jenny Jump Mountain, and was analyzed and found to be an ore of arsenic. The specimen yielded 15.60 per cent. of sulphur, and 29.80 per cent. of arsenic. Mineralogically, it is arsenopyrite or mispickel, with probably some lölingite, but the specimen was too small to determine the latter with certainty. In the report on the Mineralogy of New York, Dr. L. C. Beck mentions this arsenical ore as occurring in crystalline limestone near Edenville, Orange County. The geological character of the latter locality is very similar to that of these subordinate ridges of the Jenny Jump Mountain range. The analysis of the New-Jersey specimen indicated traces of cobalt and nickel, but no silver could be detected. It is probable that the traditions of silver ore on this mountain are based upon this arsenical pyrites. This ore associated with other combinations of arsenic, nickel, cobalt, iron and sulphur is worked in Saxony, and extensively at Reichenstein, in Silesia, as a source of metallic arsenic, arsenious acid, or white arsenic, the pigments realgar and orpiment, and for other arsenical compounds used in the arts. The extent of the occurrence, and the character of this ore, are matters to be more fully studied, before deciding upon its probable value.

CANFIELD'S PHOSPHATE OF LIME AND IRON-ORE BED.

This new and extraordinary bed of apatite and magnetite was discovered the past season. It is at Ferro-Mont, on the Dickerson Mining Company's property, a few rods northeast of the store and by the side of the public road. The line of attraction passing through it can be traced for 1000 feet, running east of the company's farm house. The bed has been uncovered at two points, by E. Canfield, and the deepest shaft is about forty feet down—measured on the slope, of which thirty-five feet was in this mixed ore. Near this, there is a fault of thirty-five feet, towards the foot wall, *throwing* the bed to the west side of the road. The bed is eight feet wide, and has regular walls of gneiss rock, in which there is little, if any, apatite. The dip is about 65° towards the southeast. The mass of the bed is a hard and firm mixture of magnetic iron ore, and greyish white apatite. Some portions of the bed show a parallelism in the arrangement of its minerals, consisting of alternate layers, or lamellar masses, of magnetite and apatite. The proportion of this latter mineral by weight may average in the whole bed, thirty-five per cent. The two are nearly of equal bulk, the phosphate being to the iron ore, in weight, as three to five, their respective specific gravities. A portion of the phosphorus is probably in combination with the iron, as the lime is not sufficient in amount to saturate the phosphoric acid, and also as the acid solution of the separated magnetite holds some phosphoric acid but no lime. A little quartz, orthoclase, and occasionally small spangles of brown mica are seen in the ore mass. The following results were obtained in the chemical examinations of an average sample, and of a specimen rich in apatite.

	AVERAGE ORE.
Matters insoluble in hydrochloric acid	11.30
Proto-sesquioxide of iron or magnetite	54 01
Lime	17.21
Magnesia	1.65
Sulphuric acid	0.07
Phosphoric acid	14.91
Total (of matters estimated)	99.15

The specimen rich in apatite gave 53.85 per cent. of phosphate of lime. The average sample contained 31.90 per cent.

Some experiments on the solubility of this ore and its phosphate were made, the results of which were as follows :

Experiment No. 1—Five grammes of the ore, heated one-half hour in twenty c. c. of dilute sulphuric acid, containing 1.27 grammes of anhydrous acid, yielded 0.27 grammes of phosphoric acid in solution. About 38 per cent. of the phosphate of lime was dissolved in this experiment.

Experiment No. 2—Two grammes of ore digested in ten cubic centimeters of dilute sulphuric acid (of same strength as in Ex. No. 1) gave 0.127 grammes of phosphoric acid in solution.

Experiment No. 3—Two grammes of the ore, treated with the same quantity of acid as in No. 2, in a vacuum, yielded 0.161 grammes of phosphoric acid in the solution.

Experiment No. 4—In this, a specimen containing about 50 per cent. of apatite was used. The iron ore was removed by means of a magnet. Of this residue, one gramme was digested in 0 73 grammes of commercial sulphuric acid, containing 0.55 grammes of anhydrous acid, over a water bath. The resulting solution contained 0.216 grammes of phosphoric acid, equivalent to 0.47 grammes of phosphate of lime.

Experiment No. 5—One gramme of the same residue as was used in No. 4, was heated in 25 cubic centimeters of dilute sulphuric acid, containing 0.55 grammes of anhydrous acid, over a water bath, and the mass evaporated to dryness; 0.237 grammes of phosphoric acid, equivalent to 0.517 grammes of phosphate of lime, were found in the solution.

Experiment No. 6—One gramme of the same residue as in Nos. 4 and 5, was treated with 0.73 grammes of commercial sulphuric acid without heat. At the end of thirty-six hours the solution yielded 0.185 grammes of phosphoric acid, or 0.405 grammes of phosphate of lime.

The residue, after the removal of the iron ore by a magnet, and which was used in Exs. Nos. 3, 4, 5 and 6, contains an average percentage of 34.5 of phosphoric acid.

From these experiments, it will be seen that the best results were obtained by the removal of the magnetic iron ore, and the digestion of the remaining mass in acid, until it was evaporated.

quite to dryness. The experiment without heat did well. The previous removal of the magnetite is necessary, as can be seen by comparing experiments Nos. 2 and 3 with 5 and 6. Its removal on a large scale would give a rich ore tolerably free from phosphorus, and at the same time avoid an unnecessary waste of the sulphuric acid in the subsequent digestion. The solution from this digestion would, on evaporation, yield a superphosphate containing more soluble phosphoric acid than the average of those in the market. The separation of the magnetite and apatite could be effected by water, in consequence of the greater specific gravity of the former, or by the use of magnetic machines. The purification of the iron sands of New Zealand, of those of Moisic, in Canada, and of other localities depends upon this difference of specific gravities, and is successfully done by washing. Magnetic machines have also been used in Canada, Northern New York, and at some European mines. For either mode of separation, a previous crushing of the ore would be necessary. The economical working on a large scale must be determined by the cost of buildings, apparatus, fuel, labor, &c. In the laboratory the profit is evident when it is understood that sulphuric acid costs from two to three cents per pound, while the soluble phosphoric acid is worth at least fourteen cents a pound. Taking the figures of experiment, No. 5, we get 73 lbs. of acid, at 2½ cents=$1.79. Soluble phosphoric acid, 23.7 lbs., at 14 cents per lb.=$3,32. And 3.32—1.79=$1.53 per cwt. of separated apatite, equal to $30.60 per ton. Whether or not this margin be broad enough to cover the expenses of the necessary manipulation is for practice to decide.

Phosphate of lime is so valued in England, that in Cambridgeshire beds of coprolites from nine to sixteen inches thick, are uncovered and profitably worked, when the overlying earth, clay &c., is fourteen feet thick. And this, too, where the first cost of the land is large. The *vein* mass or material from these beds is washed, and then made into superphosphate, in the same manner as bones and some native guanos The washed coprolites contain on an average 56 to 60 per cent. of phosphate of lime, and sell at fifty shillings, or about $13.50 per ton. In Nassau, Germany, the mining of native phosphate of lime as a source of superphosphate has attained large dimensions. In 1867, the product of the Lahn and Dill districts, in that province, amounted to 62,500 tons. The average price of this native phosphate was about $9 per ton—*i. e.*, for such as contained from 60 to 70 per cent. of phosphate of lime. In our own country the phosphatic deposits of South Carolina yield a large amount of raw material for the manufacture of superphosphates.

As an additional source for such material, this new and extraordinary mine appears to be worthy the attention of those interested in and conversant with the business of manufacturing superphosphates.

MICA MINES.

The first to be described is located about three miles north of Stewartsville, and on the west bank of Merrill Creek, Harmony Township, Warren County. The valley is narrow, and in places ledges of rock crop out so that much of the surface is too stony for cultivation. At several points the soil contains a considerable proportion of mica, indicating the existence of this mineral in the underlying rocks of the valley. In the disintegration of the rock, this has been left unchanged, as one of the constituents of the resulting rock covering.

The openings in the exploration of the company are a few feet above the stream, and just below a shoulder or rib of the sidehill. The most northerly of these is a drift running twenty feet into this shoulder. At the further end it is about fifteen feet deep, and its average width is 2½ feet. The heading of this drift is in gneiss, as are the side walls. The whole mass of the vein is mica, the cleavage planes lying in all directions. South of this drift there is a broader excavation in the hill side, it being about twenty-five feet long, and eighteen feet deep. Here the mica appears to be in veins one to two feet thick, traversing the gneiss of the hill. This latter rock is micaceous, with some beds of a granitoid character. Associated with the mica, occur quartz, feldspar and asbestus. Some portions appear to be mixtures of whitish pyroxene and mica. Between these two openings, and south of the last described, there are several excavations of lesser depth, but all showing the same general character—veins of mica traversing the gneissic beds of the country. The mica may be considered as constituting the mass of granitic dikes, which lie in, and cut the bedded rocks of the district, differing from ordinary granitic and syenitic dikes of our azoic formation in the larger proportion of mica, amounting, as it occasionally does to an entire exclusion of the minerals usually accompanying it, and forming the mineral aggregate of such masses. The mica of this locality is a brown potash variety. known as muscovite. In thin plates it is transparent and almost colorless. The present company made these openings the past summer, under the superintendence of their agent, R. J. Rymer, of Stewartsville. The explorations already made show that the masses of mica are quite irregular in their extent, and from the known character of such dikes nothing can be predicated of them with certainty, beyond what is in sight.

Another, so-called, *mica mine* has been opened during the year past by Clarkson Bird, of Broadway, on Scott's Mountain, about one mile north of that village. The property was leased from J. Fritts. The *mine* is on the southeast slope of the ridge, near the road to Springville. It consists of two small excavations, about twenty feet apart, one being about fifteen feet (vertically) higher up on the hillside. The covering was about four feet thick of rotten gneiss and earth. The mica is free from impurities or admixture of other minerals, but the cleavage planes are much bent and not very large—not generally exceeding a few inches square. The upper portions of the micaceous mass are quite loose, so that the plates are easily split out. Deeper, the mass is more solid, and the plates appear larger. The surface of the vein or dike dips or descends westerly into the face of the hill. The rock on top of the vein is a crumbling gneiss, consisting of orthoclase, brown muscovite, and a small per centage of vitreous quartz. Some of the mica from the bottom will measure 8x10 inches. Thus far the work has been for exploration alone.

The mineral here is the same as at the mine of the last described locality, muscovite, excepting that it is darker colored, being a deep brown, to amber color. The surface indications of the same ridge, further to the south, are favorable to the existence of the same mica dikes beneath.

ROAD MATERIALS AND ROADS.

Good roads are essential to any community that would thrive. The losses in time, wear of teams and carriages, and diminished amount of work done, are enough to take off a large share of the profits of ordinary business. Up to a very recent date bad roads have been the rule, and good ones the exception in New-Jersey. Heavy sand in the southern part, and mud and stones in the northern and middle portions of the state have too often been the road materials.

In our southern counties there is an abundance of gravel and gravelly loam, and nearly all of the ground is naturally well drained. In such case, it is easy to make good roads. It is only necessary to shape its surface to the proper form, to make ditches and drains to carry off all the water, so that none shall stand upon the road or on the sides near its level, and then to cover its surface from six inches to a foot in thickness with gravel, containing loam enough to make it pack, and the road is done. Most excellent roads are made in this way. And there are hundreds of miles of them in the different counties of Southern New Jersey, over which it is a delight to drive. There is no reason why all the roads should not be of this character. Their cost varies from $1,000 to $1,500 per mile, according to the greater or less distance that the gravel has to be carted. In a few instances, this turnpiking has been done by the townships, but much more has been the work of private corporations acting under charters from the state.

In the northern half of the state there is much more difficulty in making good common roads, gravel is not so abundant and the soil is not so well underdrained. Roads that remain in good order throughout the year are not common. Those about Madison, Morris County, possess this excellence, and they make it one of the most attractive and desirable places of residence in the whole state. Roads generally, wherever the soil is not dry enough, must first be drained by tile or stone underdrains, and then made of the proper form and graveled. In Orange, Essex County, trap rock has come into use for making roads, with the most satisfactory results. The material is hard and tough, and the roads made of it are solid, smooth and durable, and for their excellence of moderate expense. They are so well liked that their use is extending rapidly. Several miles are already built. This has been done by property owners, by townships, and by street commissioners. High street, in Newark, and South Orange Avenue, are both in process of paving with it. It is known as the Telford pavement, and I copy a description of it from the specifications for that in High street, which were sent me by Francis H. Dawes, Esq., of Newark :

" The roadway to be excavated, graded and properly leveled to a depth of sixteen inches below the top of the gutter-stone ; the form of the cross-section to be in every respect the same as that to be given to the surface of the pavement. The road bed is then to be rolled with the steam roller until approved by the Street Commissioner. On the road bed thus formed, a bottom course or layer of stones of an average depth of eight inches is to be set by hand in the form of a close firm pavement, the stones to be placed on their broadest edges, lengthwise across the street, and so as to break joints as much as possible ; the breadth of the upper edges not to exceed eight inches. The interstices are then to be filled with stone chips, firmly wedged by hand with hammers, and projecting points broken off. The whole surface of this pavement to be subjected to a thorough setting or ramming with heavy sledge hammers. The intermediate layer of broken stone is then put on to the depth of six inches, the stones to be broken to a size not exceeding three inches diameter, and thoroughly rolled down with the steam roller, after which the surface layer of broken stone, of a size not exceeding two inches in diameter, is to be put on and evenly spread to such depth as may be required to bring the surface when thoroughly compacted with the steam roller, to the proper grade and cross section ; making the total depth of broken stone eight inches, and the entire thickness of the pavement, when completed, sixteen inches. Any irregularities appearing during the rolling are to be carefully filled with additional material, so as to produce an even surface. When the surface is thoroughly rolled, a binding, composed of the screening and detritus of the broken stones with sand, is to be spread thereon, sprinkled, and thoroughly and repeatedly rolled with the steam roller until the surface becomes firm, compact and smooth. Any binding material remaining on the surface is then to be swept off and removed. For the foundation, any stone not liable to be affected by the action of the frost may be used after having been approved by the Street Commissioner. The broken stone in the intermediate and surface layers to be exclusively of trap rocks !"

When the traffic is lighter over the road the broken stone may be thinner—down to twelve or even ten inches, and the breadth may be less—sixteen or twenty-four feet. The cost of these roads varies with the distance to which the broken stone has to be hauled. That in Main street, Orange, which is sixteen inches deep, cost $1.90 a square yard. Centre street, which is paved thirty feet wide and a foot deep, cost $2.50 a running foot. The road going up the mountain is twenty feet width of pavement, and from eight to twelve inches depth of stone, and was built for one dollar a square yard. The road from the stone-breakers, on the Northfield road, for a mile down, waa graded and paved for a dollar per running foot. The contract for paving High street, Newark, was let for $1.90 per square yard, which was probably too low. Other contracts for like work have been taken at $2.25 to $2.50 a square yard. The stone is broken in a Blake's rock crusher, and when driven by a ten or twelve horse engine, ninety tons or sixty cubic yards can be broken in a day. Daniel Brennan, jr., of Orange, has done a large part of the work there, and his arrangements for doing it are very complete. He quarries the stone near the top of the First Mountain, and the breakers are so located that the carts dump the stone close to them, and the broken stone are elevated, sorted and deposited in proper shoots by machinery, and wagons are driven directly under the shoots and the stone falls into them, thus needing no handling. The excellence and economy of these roads is such that I am sure it will be a great public benefit to have them more thoroughly known. I do not think that better stone roads can be found anywhere in the world than these in Orange; and it will be worth while for any who are considering the subject to go and see them.

Trap rock is abundant in all the middle portion of the state. Bergen Hill, and its extension to the Palisades, is of this rock, so are the First, Second and Third Mountains west of Newark extending from Pluckemin and Somerville to Paterson and almost to the state line. Rocky Hill, Mt Rose, Sourland Mountain, Goat Hill, Pickle's Mountain, and many smaller outcrops in the red sandstone region are of this same rock. The gneiss and gray rocks of the Highlands furnish a good material for stone roads, but not equal to the trap. The stone is not so tough, and it wears into dust much faster. Limestone is a still softer rock, and, of course, is not so well adapted for this purpose.

Those who are curious in regard to the literature of this important subject, will find in the Reports of the United States, Commissioners, on the Paris Exposition, a capital one by Arthur Beckwith, C. E., "On Macadamized Streets and Roads." The Legislature of Massachusetts, for 1869, offered prizes for the best essays on roads and road-making, and a valuable document is published containing interesting and instructive essays, to which the prizes were awarded. The annual reports upon the New York Central Park also contain accounts of its excellent roads.

LIMESTONES AND LIME.

The limestones of the northern part of the state continue to furnish a large amount of lime for agricultural purposes. The yearly product of our kilns has not, however, greatly changed within the past three or four years, and the business has not moved from the localities mentioned in the "Geology of New Jersey," in 1868. In that report the superiority of the non-magnesian limes to the ordinary dolomitic or magnesian limes and the localities where such pure or non-magnesian limestones occur, were indicated, (see pages 388, 396—399, 400—404, and 410—413 of "The Geology of New Jersey, Newark, 1868."

During the past season, some crystalline limestones from the valley of the Wallkill, Sussex County have been analyzed, and three of the analyses are here presented:

	No. 1.	No. 2.	No. 3.
Lime	51.06	53.53	51.96
Magnesia	3.02	1.73	2.92
Oxide of Iron and Alumina	0.80	0.50	0.20
Carbonic Acid	43.44	43.97	44.03
Graphite and matters insoluble in acids	1.40	0.55	0.20
	99.72	100.28	99.31

No. 1 is a surface specimen, from near a new kiln on lands of J. B. Titman, northwest of Sparta. No. 2 is the ordinary white or crystalline limestone, which is burned at Franklin Furnace. No. 3 is from West Vernon, and was sent to the Survey laboratory by J. H. Brown, of Franklin. None of these specimens are dolomitic or true magnesian. The practical value of these as a source of lime is yet a matter of experiment, and the results to be obtained are looked forward to with interest and hope. And the opening of the Midland Railway which passes directly across these beds of limestone will make them available for a large district of country.

◆

The officers of the Survey will take pleasure in analyzing specimens of ores, minerals, fertilizers, &c., which are found within the state, and promise to be of public interest. They may be sent to **Prof. George H. Cook**, State Geologist, New Brunswick, N. J.

APPENDIX.

Publications of the New Jersey Geological Survey.

Geology of New Jersey, 899 pages large octavo, illustrated by 108 photolithographic engravings and woodcuts, and six mine maps; and accompanied by a portfolio containing the following maps, in sheets:

1. Azoic and Paleozoic Formations, including the iron-ore and limestone districts; colored; scale 2 miles to an inch:

2. Triassic Formation, including the Red Sandstone and Trap-rocks of Central New Jersey; colored; scale, 2 miles to an inch:

3. Cretaceous Formation, including the Greensand Marl Beds; colored; scale, 2 miles to an inch:

4. Tertiary and Recent Formations of Southern New Jersey; colored; scale, 2 miles to an inch:

5. Map of a Group of Iron Mines in Morris County; printed in two colors; scale, 3 inches to 1 mile:

6. Map of the Ringwood Iron Mines; printed in two colors; scale, 8 inches to 1 mile:

7. Map of the Oxford Furnace Iron-ore Veins; colored; scale, 8 inches to 1 mile:

8. Map of the Zinc Mines, Sussex county; colored; scale, 8 inches to 1 mile:

Price of the book and portfolio of maps, $6.50.

Geology of New Jersey, as above, without portfolio of maps, but containing a folded and colored map of the State, on a scale of 5 miles to 1 inch. Price, $4.00.

Geological Map of New Jersey, on a scale of 2 miles to 1 inch; colored and mounted on rollers. It gives the Geology of the State the same as Maps 1, 2, 3. 4. in the portfolio, and is essentially these combined in one map. Size 5½ by 7¼ feet. Price $8.00 per copy.

The prices are fixed to merely cover the cost of paper, printing and binding; the expenses of the Survey and preparing book and engravings being paid by the State.

These publications can be had from Prof. George H. Cook, State Geologist, New-Brunswick, on remitting the price, or through the booksellers.

The books are also kept for sale at these prices by William T. Nicholson, of Trenton; Morgan & Shivler, of New-Brunswick; M. R. Dennis & Co., Newark, and D. Van Nostrand, of New York City.

The work is in the following public libraries, where it can be consulted:

In all the State Libraries; in some other of the large public libraries in different parts of the United States, and in all the public libraries in New Jersey, and in the adjacent cities of New York and Philadelphia. It is also in the offices of most of the County Clerks.

The Annual Reports for 1869, 1870 and 1871, can be had on application to the State Geologist.

J C Branner

ANNUAL REPORT

OF THE

STATE GEOLOGIST

OF NEW JERSEY,

FOR THE YEAR 1872.

TRENTON, N. J.:
THE STATE GAZETTE—MURPHY & BECHTEL, BOOK & JOB PRINTERS.
1872.

Cat.

ANNUAL REPORT

OF THE

STATE GEOLOGIST

OF NEW JERSEY,

FOR THE YEAR 1872.

TRENTON, N. J.:
THE STATE GAZETTE—MURPHY & BECHTEL, BOOK & JOB PRINTERS.
1872.

GEOLOGICAL SURVEY OF NEW JERSEY.

BOARD OF MANAGERS.

His Excellency, Joel Parker, Governor, and *ex officio* President of the Board.

Hon. Andrew K. Hay, Winslow.
Charles E. Elmer, Esq., Bridgeton.
Hon. William Parry, Cinnaminson.
Hon. Henry S. Little, Matawan.
Selden T. Scranton, Esq., Oxford.
Henry Aitkin, Esq., Elizabeth.
Hon. Augustus W. Cutler, Morristown.
Abram S. Hewitt, Esq., Ringwood.
William M. Force, Esq., Newark.
Thomas T. Kinney, Esq., Newark.

STATE GEOLOGIST:

GEO. H. COOK, New Brunswick.

To his Excellency, JOEL PARKER, *Governor of the State of New Jersey, and ex-officio President of the Board of Managers of the State Geological Survey :*

SIR : I have the honor herewith to submit my report upon the operations of the Geological Survey for the year 1872.

GEO. H. COOK,
State Geologist.

RUTGERS COLLEGE, New Brunswick, N. J.,
December 10th, 1872.

REPORT.

The operations of the survey have been continued during the past year by the following persons:

Prof. John C. Smock has been engaged for a portion of the year. His work has been mostly in the iron ore region, and he has done much in the exploration of ground supposed to contain iron ore, and in the examination of new or extended openings.

Edwin H. Bogardus, chemist, has been engaged in the laboratory most of the year. His principal work has been analyzing iron ores, limestones, clays, soils, and fertilizers.

Prof. Edward A. Bowser has been in the service of the State only a small part of the year. He has surveyed and mapped several iron mines, and has lately been engaged in a partial examination into the condition of the monuments on the boundary line between New Jersey and New York.

My own time has been occupied in some degree in the field, but much more in office work, and in furnishing information to persons seeking it, in regard to various natural products of the State. Work connected with different drainage projects, now in contemplation, and which the Legislature has placed under the direction of the board of managers of the geological survey, has taken much valuable time.

PRESENT CONDITION OF THE WORK, AND PLAN PROPOSED FOR ITS COMPLETION.

The time contemplated in the act continuing the geological survey closes with the present year. Such a work can never be finished, and it would undoubtedly be for the best interests of the State if it were continued on, much further than it has yet been. The field work, however, is in such condition that it can be closed, and a report made upon it. The interruptions caused by work under the drainage law has not left time to write out in full the details of our iron mines and ores, or the generalizations upon our soils and our agriculture which the analyses and surveys have prepared the way for. The reports upon these two subjects are partly written out now, and will be completed by Prof. Smock and myself as fast as the studies connected with them can be carried forward. Elaborate mine maps have been prepared to accompany the "Report upon the Iron Ores and Iron Mines." It is proposed to issue these two reports separately, and in such way that they may be freely distributed among those most interested in the subject. There is a small balance of the appropriation still unexpended, which can be used to meet some unavoidable expenses, and we shall endeavor to complete the publication of our results as originally contemplated.

The law for completing the geological survey of the State, in which the board of managers and the State geologist were named, made provision for its surveying expenses for four years, and afterwards made provision for its further continuance four years longer. It also empowered the board of managers to pay the expenses of publication. The functions of the board are not limited in time, and the act to provide for the drainage of lands puts the work of making plans for drainage under the direction of the board of managers of the geological survey, and as such improvements are likely to continue for a long time yet, there is an obvious necessity for the board to continue its organization.

Should the board deem it best to have the northern boundary re-surveyed, and the condition and location of the monuments carefully examined and recorded, it will be necessary to ask for an appropriation to meet the expenses this would require.

PUBLICATIONS OF THE SURVEY.

The Geology of New Jersey with the accompanying portfolio of maps has been supplied to such institutions and libraries as have made application for it; and it is finding its way into the places where it can be used for its appropriate purpose as a book of reference. The annual reports for 1869, 1870, and 1871, have been extensively distributed already, and there is still a demand for them. The Geology has been sold at the cost of printing and paper; and the annual reports have been supplied gratuitously to all who apply for them. For present and general use, it appears that the small reports issued in pamphlet form are much more generally distributed and read than larger bound volumes.

THE ACT TO PROVIDE FOR THE DRAINAGE OF LANDS.

In the last report it was mentioned that an act, with the above title, had been passed, and that "the board of managers of the geological survey, on the application of at least five owners of separate lots of land included in any tract of land in this State, which is subject to overflow from freshets, or which is usually in a low, marshy, boggy, or wet condition, shall be and are hereby authorized and empowered to examine such tract, and if they deem it for the interest of the public, and of the landowners to be affected thereby, they are further authorized, from time to time, to make surveys of any such tract or tracts of land, and to decide upon and adopt a system of drainage for draining the same, and to cause maps of the same, together with the plans of drainage by them adopted, to be made; and, for this purpose, they shall be authorized to call in the assistance of the state geologist and such other persons as they may deem expedient; and when they shall have completed their said surveys, maps and plans, they shall make a written or printed report of the same to the Supreme Court of this State; and thereupon it shall be the duty of the said court, at the same or next stated term thereof, or as soon as can conveniently be done, upon reasonable notice given to that effect, and published in a newspaper circulating in the county where such tract of lowlands is situate, to appoint three commissioners (not interested in the lands to be drained) to superintend and carry out the drainage of any particular tract or tracts aforesaid, whose duty it shall be to carry out and execute the system of drainage which may thus have been adopted and reported by the said board of managers in reference to said particular tract or tracts; *provided*, that if, at the time fixed for such appointment of commissioners, it shall appear to the court by the written remonstrance of the owners of a majority of the said low and wet lands, duly authenticated by affidavit, that they are opposed to the drainage thereof at the common expense, then the said court shall not appoint such commissioners as is directed in this section." Other sections prescribe the mode of proceeding to execute the work, to assess and collect money to pay the expense, to compensate for damages, and to perform all acts necessary to carry out the contemplated work of drainage. It was also reported that under this law proceedings had been instituted for the drainage of three tracts of wet land, viz:

1. The tract of land subject to overflow, bordering the Passaic river, between Chatham and Little Falls, in Morris, Essex, and Passaic counties.

2. The wet and overflowed lands on the Passaic river, between Millington and Chatham, in Morris, Union, and Somerset counties.

3. The wet and boggy land in the Great Meadows on the Pequest, in Warren county.

The application for the appointment of commissioners to execute the drainage works, in the first case, was strongly and ably contested by the owners of the water-power at Little Falls, and the arguments in the case were heard at the November term of the Supreme Court, in 1871. Objection was made to the constitutionality of the law upon various points, and also to the way in which the notices had been published. No decision of the court was announced at that term. But at the June term of this year, the opinion of the court was fully declared upon all the points which had been submitted to it. The constitutionality of the law was sustained in every respect. The simple publication in the newspapers of the intention to apply to the Supreme Court for the appointment of commissioners to execute the plan of drainage, was judged insufficient, and full and specific instructions were given as to the form of notice, its publication, posting in public places, and personal service upon those whose property might be damaged by the works to be executed. The case was continued, with opportunity to correct the deficiencies in notices. The notices have since been given in accordance with the directions of the court, and at the November term of this year the application was renewed; and the court has appointed Aaron Robertson, of Morris, Martin John Ryerson, of Passaic, and George W. Howell, of Morris, commissioners to carry out and complete the plan of drainage prepared by our board. It is but a few days since this appointment was made, and I am not informed whether any further steps have yet been taken in the matter.

In the second case, the application was met by a remonstrance from a considerable number of landowners who objected to the work being done at the common expense, and affidavit was made by one of the signers that he believed the persons signing the remonstrance were the owners of more than half the land to be drained. No further proceedings have yet been had in the case.

The third case has had no opposition, and, the notices being in proper form, when the application was made to the Supreme Court at its last term, it was immediately granted, and Amos Hoagland, James Boyd and Samuel S. Clark were appointed commissioners to carry out and execute the plan of drainage prepared by this board. There has not yet been time for further progress in the matter.

The projects for drainage have, so far, been slow and tedious, but opportunity has thus been given for a full discussion of the questions of law that were involved in the working of the act, and the way has thereby been smoothed for works of this kind to go forward without interruption or protracted delays.

There are a number of tracts in the State where the agency of this law could be used for both public and private benefit. And as the great improvement which drainage effects is more generally seen and known, so works for its accomplishment must be extended.

In the cases already brought before the board, the plans for drainage were prepared after a careful survey and examination of the tracts and the channels for carrying off the water, and great confidence was felt that nothing was proposed but what was absolutely essential to the success of the improvement demanded. In order, however, to give the fullest assurance as to the correctness of the plans proposed, it was thought desirable to get the opinion of some engineer outside the officers of the survey. Application was accordingly made to Ashbel Welch, at present chief engineer of the railroad works at Harsimus Cove, and who for forty years past has occupied responsible and prominent positions in the construction of public works in this State. He generously, and with considerable trouble to himself, went carefully over the three tracts to be drained, examining into the condition of the lands, and the plans proposed for their drainage.

The questions submitted to him were :

1. Is the drainage of the lands in question necessary to their proper improvement, and of public importance?

2. Is the work proposed in these plans essential to the beginning of any system of permanent drainage?

3. Will the works effect the objects for which they are planned?

4. Can they be carried out without being burdensome to the landowners?

The answers to these questions were received in the following letter:

TRENTON, September 17th, 1872.

To Prof. Geo. H. Cook, State Geologist of New Jersey:

MY DEAR SIR: I have your favor of the 6th instant, asking my opinion of your plans for draining the wet lands which I visited with you along the Passaic river and its branches, and along the Pequest. In answer to your questions I reply:

1. The drainage of the lands in question is necessary to their improvement, and is of public importance.

2. On the Passaic, the work proposed is essential; on the Pequest it is important, but some of the lands on the latter stream can be partially reclaimed without it.

3. The proposed works will effect the objects intended, that is, afford an outlet for the local drainage to be subsequently effected on the lands themselves.

4. If I were one of the landholders, I should be glad to contribute to the expense rather than miss the improvement.

Very respectfully yours.

ASHBEL WELSH,
Civil Engineer.

This endorsement of our plans by our eminent and justly valued citizen and engineer is gratifying to this board, as well as assuring to those interested in the success of the improvement.

THE BOUNDARY OR PARTITION LINE BETWEEN NEW JERSEY AND NEW YORK.

The division line between New Jersey and New York is not defined by any natural objects, such as fix the limits of the State on all its other sides. The northern boundary was long in dispute, but was at last defined by agreement as a straight line, having its eastern end on the west bank of Hudson's river, at 41° north latitude, and its western end at the junction of the Machockemack or Neversink river with the Delaware. Our Legislature, by an act passed September 26th, 1772, appointed commissioners to establish this line, who, with other commissioners appointed by the Legislature of New York, did trace out, define by stone monuments set at the end of each mile, and marked by blazed trees along the line, the boundary in question. No record of this work has been found among our documents, but a copy is in Albany, among the Clinton papers in the office of the Secretary of State of New York. The New Jersey commissioners were James Parker, John Stevens, and Walter Rutherfurd; and those from New York were William Wickham and Samuel Gale. The surveyors were James Clinton, of Ulster county, New York, and Anthony Dennis, of Monmouth county, New Jersey. The commissioners' report is dated November 30th, 1774; a complete copy of that and the surveyors' report is to be found in the Geology of New Jersey, 1868, pp. 1 and 2. They state that the line was run N. 54° 40′ W., as the magnetic needle then pointed, and that the distance was 48 miles and 38 chains. Almost the whole of the line was run through woods, over a very rough country, and in some parts the compass needle was so much affected by local attraction that they were obliged to correct the error "by staking." In the long time which has elapsed since that line was run, several of the monuments have been broken down. The 15th, which is not far from Sufferns station on the Erie railway, is broken off, and lies beside the adjacent fence. The 26th, which was on the west bank of

Greenwood lake, is broken down and now lies in a pile of stone near its original location; and the 44th, which is four-and-a-half miles from the west end, is said to have been broken down and burned into lime; some others have been looked for and not yet found. In some cases, the monuments, as they now stand, are not in a straight line. Those from the 19th to and including the 26th, are quite out of line, and such is said to be the case with those from the 27th to the 31st. The mark for the western end of the line is not described by the commissioners or surveyors. There is a slight mark, a kind of crowfoot, on the rock near the water's edge, at the junction of the Delaware and the Neversink, which is said to be the end of the line.

On account of the lost monuments, the obvious crookedness of the line through those which are standing, the ease with which they can be moved, and the enormous value of some of the property along the line, its true location as run by the commissioners has become a matter of question. And serious cases of State jurisdiction may arise at any time, in regard to it.

From all this, it is evident that something should be done to determine the present condition of the line and its monuments, and to so describe and record the successive monuments that they can be verified easily and without delay. A careful survey of the line according to the monuments should be made. The exact latitude and longitude of the western end should be determined; and with the latitude and longitude of the eastern end, which is now known, the bearing and length of the line could be computed, and any errors in the present one made to appear. And should it be found desirable, some joint action could be had with the State of New York, and the line again traced out, marked and recorded.

IRON ORES.

MAGNETIC IRON ORE.

The mines of magnetic iron ore continue to be worked with vigor, and the number of localities furnishing ore are steadily increasing under the impetus from the urgent demands of the furnaces for larger supplies. All of the mines which were included in the report of last year, have been worked a portion if not all the past season, and their number has been increased by the resumption of work at several old mines which had been idle since the close of the war. In the iron districts of Morris county, larger quantities of ore have been raised this year than ever before, the Hibernia mines having furnished a total of 90,000 tons to the Hibernia Mine Railroad for the eleven months of the year; whereas, in 1871, they sent only 80,000 tons. At Mount Hope a large excess is reported over the returns of last year. The shipments of the Ogden Mine Railroad will be about the same as in 1871. The ore tonnage of the Morris and Essex Division of the Delaware, Lackawanna and Western Railroad is 404,832 tons, while that of 1871 was only 232,966—being nearly one hundred per cent. increase. More than four fifths of this is the product of the mines of this county.

The completion of the New Jersey Midland Railway has given a new outlet to the mines of parts of Sussex, Morris and Passaic counties, and already several of them are sending their ores over this road. The branch of this railroad which is now being constructed in the valley of the Ringwood creek and along Greenwood lake, traverses a district particularly promising, and affords an easy outlet for the rich and extensive ore deposits of Ringwood. Some recent discoveries of large ore outcrops near this new line are reported, so that its prospective tonnage is large, and the addition of the product of this portion of the State to the aggregate of all our mines may be equal to that contributed by the most extensively worked of the old localities or districts. When it is considered that only one-seventh of the surface of the Highland range lying north of the Morris and Essex Railroad is cleared land, and that, hitherto, small deviations of the compass (or, light attractions) have been regarded as unworthy of further attention or testing, and that ore when found has been of little more value than so much rock from the adjacent strata in consequence of a lack of cheap transportation, it becomes apparent that the mineral wealth of this portion of the State is comparatively unknown, and that here is a field for all interested in the development of its natural resources, or in the mining of iron ore.

In Warren county there has been a great deal of prospecting in the way of surface operations, especially in the vicinity of Hackettstown, and thence southward towards Washington; but, thus far, they have not yielded any very definite results. Ore has been uncovered in many places, but in most instances it has been found as a constituent mineral of granitic and syenitic *dykes* — more rarely in gneissic *strata*. Much searching with the dipping needle has been over such ore-bearing rock, and in some cases it has misled explorers. And in this connection it may be stated that while such rock masses may be closely related to ore beds, the probabilities of their leading to such beds or *veins* are not strong enough to justify much labor or expense in the search after them. This geological feature is not confined to this portion of Warren county, here mentioned, since it can be seen at many points in the gneiss rock formation. But there is a marked distinction between this mode of occurrence and that of the regular ore beds, or veins, as they are commonly called. These latter have definite and well marked walls of rock, and the ore-masses conform to the strata of the rock. The dykes may be conformable to the adjacent beds, but, generally, they are not so, sometimes cutting across the strata. In nearly all cases they are *true* veins, or dykes, and the distinction between them and the beds of ore, or *veins* as the term is commonly employed, should be more frequently borne in mind by all engaged in such searches, as attention to this phenomenon will save both time and money.

West and southwest of Hackettstown, along the east side of Jenny Jump mountain, the mines opened two years ago have yielded largely, and new outcrops have added to the reputation of this newly-discovered ore belt. The Pequest and Kishpaugh mines have been vigorously worked, and have demonstrated the existence of large and profitable veins where the surface indications were slight, and were for a long time overlooked as not sufficiently marked to warrant any further exploration. Near the northeast end of this mountain range several veins have been discovered on the Howell farm. This lies west of the Johnsonburg road, and between it and the Great Meadows. The diggings are on a white limestone ridge near its northern end. This limestone is mixed with granite, steatite, and other yet undetermined rock species, the relations of which are not fully understood. The Shaw mine, mentioned in "The Geology of New Jersey," is about a quarter of a mile southwest of this Howell farm mine. The ore obtained here is of a superior quality, containing a notable percentage of manganese, some carbonates of lime and magnesia, and very little phosphorus and sulphur. The limestone is mixed with the ore, but not so largely as to greatly reduce the percentage of metallic iron, which is 58.5 per cent.

Between this and the Kishpaugh mine, ore has been found at a number of points, but the localities are not yet sufficiently developed to require any further notice. Apparently on this same long line of outcrop is what is termed the Redell mine, about a mile and a half northwest of Oxford. Here the crystalline limestone is but a few rods from the ore, and this, too, contains manganese. So that, these outcrops may be said to be characterized by the presence of manganese and their association with crystalline limestone. Towards the northeast a manganiferous iron ore occurs at the mine worked some years ago by the Glendon Iron Company, and hence known as the Glendon mine. This is about two miles southwest of Andover. Near the latter village is the noted Andover mine, and a little further eastward is the Roseville mine, at both of which the same association of minerals may be observed. Still further to the northeast are the iron ore mines at Franklin Furnace. Corresponding with this line of ore outcrop, there is the longer line of white or crystalline lime stone, extending from Mounts Eve and Adam, in Orange county, New York, to Marble mountain at the Delaware river, and skirting the northwest border of the Azoic formation throughout its whole length. The age of this limestone, and the rocks of this northwest border, as compared with those of the Highland range further to the east and southeast, is unsettled. Whatever it may be, the association of this ore with the limestone and the almost universal presence of manganese, are remarkable, and indicate the possibility of finding some order in the distribution of the iron ore beds throughout the gneiss-rock formation of our State.

It is impossible at this time to get sufficient returns of the ore carried by the railroad and canal lines from stations within the State, and so to get at the total product of the iron-ore district; but from data received from some of the companies, and from estimates by those well acquainted with the mining operations of the State, the aggregate amount for 1872 may be put at 600,000 tons. At five dollars per ton, this would give $3,000,000 as its value at the mines. As compared with the other States of the Union, New Jersey stands fourth, being exceeded by Pennsylvania, New York, and Michigan. And yet as large as this may appear, it is considerably less than the present capacity of the mines as now working, and far below what might be done under more comprehensive plans, which would result from more extended examinations as to the extent of the veins, or which would follow from the consolidation of interests or a co-operation in mining operations. In many instances, these could be very much simplified, and the capacity of a vein greatly increased by uniting the management. The heavier the interests, the more work in the way of exploration becomes possible, and then follows, as a natural sequence, the adoption of more comprehensive and economical modes of mining. In view of these facts, and the probable constancy of the large veins even beyond workable depths, the acquisition of mine property and the consolidation of interests, is a subject that should attract the attention of capitalists, more particularly in these days of high-priced iron. And as a matter which favors the development of our resources, it is here recommended as worthy of consideration.

HEMATITES.

The total product of the hematite mines of the State is greater than it was in 1871, but the localities where such ore has been mined are the same as given in the annual report of that year. In Sussex county, the Pochuck, Cedar Hill and Edsall mines have been worked a part of the year. At the Pochuck mine a tunnel is being driven through the narrow ridge east of the old openings, so as to afford an easier and more expeditious mode of getting the ore to the railroad. The workings are under ground, and the deposit resembles that of some of our magnetic iron-ore beds in its gneissic rock walls, which dip at a high angle towards the southeast. The recently opened Cedar Hill mine is a short distance northeast from the old mine, and on the east side of the ridge. Here the rock, west of the ore, is the white crystalline limestone, which forms the mass of the ridge, while under the ore, on the southeast, a siliceous conglomerate, consisting of white quartz pebbles, in a greyish matrix, also siliceous, crops out. Further work will show the true relations of these rocks and the ore at this interesting locality. Both of these mines are owned and worked by the Franklin Iron

Company. The early completion of their large blast furnaces during the coming year will create a demand for the ore of these mines, and stimulate the search for additional sources of supply.

The hematite mines, near Beattyestown, in Warren county, have been idle most of the year. Quite recently, they have come into the possession of the Musconetcong Iron Works, and a more vigorous working of this deposit may be expected in the future. South of the property held by these companies, and on adjoining farms, this ore has been found in workable quantities. These discoveries, with the results of borings made on the lands of the companies above mentioned, indicate an extensive bed or deposit of ore. It lies between the outcrops of the limestone and the slate, and deeper excavations will no doubt show that it rests upon the limestone. From these mine holes, southward as far as Pennwell, in the deep valley of the Musconetcong creek, hematite has been found at intervals both in trial pits and in the surface stratum, but, so far, not in sufficient amounts to lead to any mining operations. These occasional appearances indicate the existence of larger bodies or deposits in the neighborhood, although some of them may be of diluvial origin—that is, boulders and boulder masses.

In the Pohatcong valley, near New Village, there is a hematite locality near the site of some old diggings for this ore. The Carpenterville mine, near the Delaware river at Carpenterville, is the only deposit of this ore in that part of the county, which is worked.

In the last annual report, reference was made to a discovery of hematite in German Valley, near the Hunterdon county line. During the past season the localities were twice visited, and the following data collected: The explorations were made under the superintendence of Isaac Hummer for J. Taylor & Co., of High Bridge. They were confined to the central and eastern portions of the valley, close to the public road which runs northward from California into Morris county, and at the foot of the Fox Hill range. The mode of search was by test pits or wells sunk in the overlying earth, mixed clay, and ore deposits, from fifteen to forty feet deep, and having a diameter of from two and a half to three feet. A pick and a spade, with handles about a foot long, were the only tools necessary in digging in so narrow a space. The hoisting of the materials was in buckets holding about fifty pounds of dirt each, and was done by the aid of a windlass made so light as to be easily moved from pit to pit by a couple of men. With these helps two men were able to do all the work. The cost of digging these pits, aside from the tools and hoisting gear which were furnished the laborers, was twenty-five cents per vertical foot. And here it may be stated that in the Lehigh Valley the contract for digging such pits or wells, two and a half to three feet in diameter and up to fifty feet in depth, ranges from fifteen to twenty-five cents per foot, being more expensive the greater the depth. At this apparently low cost laborers make good wages, an experienced man being able, under favoring circumstances, to go down twenty feet in a day. Such an easy, and, comparatively, inexpensive mode of search, is admirably adapted to explorations for hematites, ochres, clays, or other earthy materials where there is no solid rock or indurated earth to be encountered, and is here recommended to all desirous of testing ground for such minerals. In German Valley, about a hundred such holes were sunk, and in most of them ore was found. A few on the upper or eastern side of the road struck the gneiss only a few feet beneath the surface. One west of the stream, and in the valley flat, sunk to a depth of forty feet, was in blue limestone, after passing through the covering of earth. The ore found in these holes was in small masses or concretions, mixed with yellowish earth and a white sandy clay, such as generally accompanies hematite. All the holes in which it was found stopped in it, one of them showing a thickness of twenty-five feet of ore. From these explorations, it appears probable that the ore occurs in a bed or deposit quite narrow, but extending for some distance lengthwise the valley near the western base of the gneissic ridge. At present, the nearest railroad to this ore deposit is at Chester, seven miles away, in a direct line. High Bridge is about the same distance, or a very little further. With a railroad traversing the valley and connecting these points, this deposit would, according to present prospects, yield largely. And here, the statement of the report for 1871 in regard to the occurrence of hematites may be repeated, viz: "As ore is most generally found near the borders of the limestone outcrop, either between the gneiss (or *grey rock*) of the bounding ridges and the limestone, or between the latter rock and the overlying slate, searches should be confined more particularly to such lines of outcrop. Explorations should, however, extend over the whole breadth of these valleys, as it is sometimes found resting upon the limestone strata, covered by quite thick beds of ferruginous loam, clay, or other earthy matter." And in such searches recourse may often be had to boring instead of digging. This is much quicker and cheaper, and preferable in not disturbing so much of the soil or any crop growing upon the ground. Stony strata, or those containing cobble-stone or large boulders, cannot be readily penetrated by an auger, but such stony beds are not common over hematites, or, if so, they constitute a thin, superficial, drift layer, and, in such cases, the boring could be started after a pit has been sunk through this top stratum. Generally, the covering consists of earthy beds, containing much clay, and an auger can easily be driven through these materials.

The increasing demand for iron ores will undoubtedly lead to the examination of much ground hitherto unnoticed, and to the discovery of additional localities where hematite may be obtained in workable quantities. And the great extent of magnesian limestone outcrops in the valleys of Warren and Sussex counties, offers a wide field for such discoveries. In all cases due attention to the character of the surface is necessary, as the presence of loose pieces of *float ore* in the soil is one of the first features to be determined before the digging of trial-pits or boring is attempted.

BORING AS A MODE OF SEARCHING FOR MINERALS.

The exhaustion of old and long worked mineral deposits, and the demand for additional supplies of raw materials, require more systematic and detailed examinations, not only of territory known to contain these, but also of those more extensive areas hitherto regarded as barren or unproductive. While there are certain general characters drawn from the geological features of the ground that may guide us in the direction which our searches are to take, indicating the probable presence of this or that mineral, the demonstration of the fact of its existence seldom comes until the miner's pick has uncovered the deposit. In the examinations for magnetic iron ore, the dipping needle furnishes sufficient directions for the removal of the overlying earth. But with the ores of the other metals not only is this unavailable, but the deposits themselves are in *pockets* or *veins*, and not in the form of strata or *beds*. In such cases, as also in iron mining, the safest rule and the one generally followed, is to stick to the bed or vein. But this is often impracticable, as the vein may grow too small for profitable working, or its course may be broken by numerous faults or offsets. Besides, companies with large capital invested in such operations, and using great quantities of raw material, need to look out for the future and to direct their work accordingly. Hence the necessity for cheaper modes of examination which may be satisfactory without being too expensive. One of these is the use of the rock drill or borer. Of such there are many styles, and some of them, as the diamond drill, work very rapidly. And although none of them can be said to work very cheaply, it may also be stated, on the other side, that every company owning extensive mines owe it to the community and the State to employ a small fraction, at least, of their income in exploring. In the oil regions of Pennsylvania, this method of testing strata has had a very extensive application. There it has been a necessity. It has also been used in the determination of the extent of coal beds in the same State, and in one instance it was seen the past season employed in fixing the limits of a large iron ore deposit. In New Jersey very little of this kind of work has been done, excepting some fruitless attempts thereby to find coal or petroleum. But in not a single case known to the survey has any boring ever been done to determine the extent of any of our iron ore beds. Every year mines are abandoned because of veins "pinching out," while others are worked on a wasteful plan on account of the uncertainties of the future. All agree that an accurate knowledge of the extent of material before the miner would warrant a more comprehensive and economic mode of working than that now followed. In view of these facts, why should we not know the limits *downwards*, or the workable depth, at least, of some of these large veins. Great folds or basins may be here as in Pennsylvania, or thin and irregular veins at and near the surface may be leaders from large and persistent deep beds. At present all is ignorance, and we have only the constancy of the past to serve as a probable hope for the future. Some of our veins may be uniform, as now opened, to a depth of 2,000 feet, or as deep as it is profitable to hoist the ore. Such an extent at a moderate dip would divide the ownership of many of our large veins, even at a depth of 1,000 feet. At these times, when ore is in such demand, this is a matter of interest to all mine owners, and to those owning property near large and continuous veins. But it is not so much a question for this latter class as for the mine proprietors. Besides so much would be added to the sum of our geological knowledge, and thereby assist in the explanation of many phenomena not now plain. Every year large sums of money are spent in fruitless, and in many cases in foolish, surface operations, looking for new veins. Not that these, when cautiously conducted, are of no value, or destitute of results, for facts alone prove the contrary. But if large results are demanded, and startling discoveries are desirable, the most promising field is in boring on some of these large and steady veins. A single boring might develop the existence of more ore than is mined in the whole State in the course of a year. These statements are based upon the firm belief in the continuity of our iron ore veins downwards, or on the line of their dip, as well as on the line of strike. In Europe boring is common as a mode of search, and some of the discoveries, particularly in Germany, have been very remarkable for the extent of deposits so tested. Its more general application in this country, and at this time in the iron districts of this State, is desirable, if not necessary to the future growth of our iron industry.

ZINC ORES.

The mines at Stirling and Mine Hills, in Sussex county, continue to yield an abundant supply of rich zinc ore. As the working of these mines goes forward, the extraordinary size of the veins is more and more apparent, and there is probably no other place in the world where so large an exposure of zinc ore can be seen as at these mines at the present time.

BUILDING STONE, SLATE, FLAGSTONE, MARBLE.

The most extensive operations in quarrying marble have been carried on by the Warren Marble Quarry Company ,at Lower Harmony, in Warren county. The quarry is at the north end of the village and at the west side of the road. It is already a large opening, exposing nearly an acre of the crystalline limestone. Although so much surface has been uncovered, the rock has not yet been penetrated further than about fifteen feet. The stratification is quite indistinct, but appears to be steep towards the southeast, to which direction the slope of the ridge conforms. The original rock surface was exceedingly uneven, in consequence of the unequal weathering of the calcareous and hornblendic portions of the mass. Most of the stone has a greyish shade, but in places it presents a banded appearance, due to alternations of lighter and and darker laminæ or lines. Nodules and irregularly shaped masses of foreign minerals, mostly hornblende and steatite, are scattered through the calcareous matrix. There is some graphite, and a very little pyrite in some parts of the quarry. The deeper excavations show a more solid and homogenous stone, quite free from these foreign minerals. The company is fully equipped with all the necessary machinery for cutting, sawing, dressing and polishing the stone at the quarry, and is filling orders mostly from Pennsylvania.

ROSE CRYSTAL MARBLE QUARRY.

This is on a subordinate ridge belonging to the Jenny Jump mountain range, and at the corner of the Hope and Danville road and the road running northward along the Great Meadows. There are two openings, but thus far nearly all the stone has been taken from that on the south side of the Hope road. This is about fifty yards long, fifty feet wide, and at the deepest twenty-five feet down. The dip of the strata is 80° N., 75° W.. The rose-colored beds as exposed measure thirty feet across the strike. On the west of these the stone is pearl-grey in color. The stone is mostly calcareous, the calcite being white, flesh-colored and rose-colored. With this there occurs a greenish black hornblende, black mica, and here and there crystals of black tourmaline. But the calcite largely predominates, so much so that it could be used for burning into lime. The stone polishes well, and these foreign minerals give it a beautiful variegated appearance.

Many of the larger blocks on the bank will measure 8x3x2 feet. They are free from seams or jointage flaws. On the opposite side of the road a trench has been dug down to the rock, exposing the strata for 100 feet or more across the strike. Here it is the ordinary white limestone and none of the colored varieties are seen. A large number of blocks have been shipped from this quarry to Philadelphia, where they have been used for interior ornamentation of public buildings. This fact may be better appreciated when it is considered that they had to be hauled seven miles by teams to Hackettstown, where they were shipped by rail to their destination.

Another marble quarry in the State is at the southwest end of Marble Mountain, near the Delaware river, and on the east side of the river road. This is a dark grey stone, the calcite being mixed with mica and hornblende. The strata seems to conform to the adjacent gneiss, both dipping 55° N., 30° W. The quarry was worked for material used in building the new Episcopal church in Easton, Pennsylvania. Since that time nothing further has been done here. The locality is interesting, geologically, but it is doubtful if it ever becomes of great practical importance.

SANDSTONE.

A new quarry for sandstone, or rather of quartzite, has been opened at the New Jersey Marble Company's quarry, on Kanouse Mountain, about a mile east of Newfoundland. There are two openings, about half way up the west side of the ridge. The southernmost, and largest of the two, forms a drift cut about 50 feet into the side of the mountain, having a breadth of about 25 feet and a depth of 18 feet. Near the surface the rock is brownish red, becoming lighter in color as the strata are penetrated, and consists of quite small grains of quartz, cemented together by a siliceous paste. The dip of the beds is 50° N., 35° W. A very regular system of joints traverses the strata nearly at right angles to their strike. These, with the stratification flaws, which are from three to fourteen inches apart, furnish long, flat stones, some of them ten feet long and three feet wide. The stone although very bard is said to dress well. The deeper portion of the quarry shows a more solid stone than that of the surface ledges. For curbing, or for lintels, posts, &c., this stone may do admirably, since it is very hard, firm, and not likely to be affected by the weather. Should it prove to be of permanent value the supply will be found to be practically inexhaustible, as not only Kanouse, but also Copperas, Green Pond, Bearfort and Belvale mountains are largely made up of this rock. And it may be possible to find other localities more accessible and nearer railroad transportation.

SLATE.

NEWTON SLATE QUARRY.

This has attained considerably larger proportions than it had in 1868, when noticed in the Geology of New Jersey. It is now about 60 feet deep, and measures nearly 70 feet on each side. The walls are vertical, being natural joints running northeast and southwest, with a second system nearly at right angles to the first set. The dip of the strata, as shown by the ribbons, is gently towards the north, while the cleavage planes descend at an equally small angle towards the south. The slate is unusually hard but splits well, requiring, however, a little more time and care in the splitting. A peculiarity of this quarry is that the stone can be "scalloped" or blasted indifferently in any direction. The stone not used for roofing slates is sold for flagging. When visited it was worked by Ramsden & Co. This quarry has furnished a great deal of material for roofing large buildings in Newton and elsewhere, and the slate has given general satisfaction.

The only other slate quarry in the State which is now in operation, is the one near the Delaware Water Gap. This is sending a large amount of superior slate into the market, and the experience of the past few years proves that it is among the best quarried in this country.

The same belt of slate in which this and the numerous quarries about Slatington, Pennsylvania, are located, extends from the Delaware river along the southeast foot of the Kittatinny, or Blue mountain, to the New York line, a distance of over 30 miles in New Jersey, and at almost any point in this long outcrop it may be possible to find good roofing slate. The great drawback at present is the lack of railroad facilities over most of this ground. Slate of good quality is said to have been found on the lands of the late John Rutherfurd, near Culver's Gap, but the place has not been visited.

FLAGSTONE.

The only quarry outside of the red sandstone formation which has been worked during the past year, is that on Flagstone hill, 3 miles north of Deckertown, Sussex county, The ease with which these stones can be taken out, their uniformity in texture, their smooth surfaces and large size, and the nearness to railroad (1½ miles west of the New Jersey Midland), renders this a valuable quarry, and with so many towns and cities on the line of this road, it ought to find a ready sale for all it can furnish. Newer openings show a great extent of valuable stone on the same hill. The rock belongs in the Hudson river slate formation of the Kittatinny valley; and other localities in the broad outcrop of this rock may be found where it has the same valuable characters as at the above quarry.

Another probable supply of good flagstone is in the thin-bedded grey sandstones of the Bearfort mountain and its foot hills, in the township of West Milford, between the Midland Railroad and the State line. The strata are nearly vertical, and in the ledges the tendency to split up into thin, smooth-bedded slabs is seen everywhere. With the railroad facilities for transportation which the two Midland railroads provide, the stone in this locality should find a ready way to market.

MISCELLANEOUS PRODUCTS.

MICA.

A mine of mica has been opened on the mountain side, about a mile north of Broadway, in Warren county. The mineral occurs in granitic veins, which cut across the strata of gneiss. The mica is in enormously large crystals, and the feldspar, in which it is imbedded, is decomposed and quite soft, so that it is easily mined. The plates of mica split very perfectly, and some of them are more than a foot across. The color is rather darker than is desirable, but the quality is good; it stands fire well, and is finding a ready sale among the stove manufacturers. H. W. Merrill & Co., of Paterson, are the owners of the mine, and they have worked it during the past season. The vein is irregular, but it promises to yield a large quantity of this valuable article. The gneiss rocks here dip towards the W. N. W. 60°, and the vein in which the mica is found runs almost square across the strata. The veins have been uncovered for nearly 200 feet, and in a strip about 30 feet wide, and at the deepest part 30 feet down. It is surprising to see so large an exposure of the thin flakes of this bright and glistening mineral. The drift which covers the surface at that place has when it moved produced some remarkable disturbances and flexures in the mica, and some of the plates are bent across so that the two parts form an acute angle with each other.

On the east side of the valley and near the Broadway station mica has also been found, and it is said to be in workable quantities.

The mine near Stewartsville, which was described in last year's report, has not been in full operation this year.

OCHRE.

A bed of yellow ochre near Upper Harmony, in Warren county, has been worked a portion of the year. The openings are at the side of the Roxburgh road, on lands of Adam Ramsey, and about a quarter of a mile north of the village. The deepest of these is 18 feet, of which from three to six feet at the top consists of gravel, earth and sand, with a few small boulders. The ochre as seen in the bank is light buff to ochre yellow in appearance. Occasionally small masses of rotten rock, originally a slaty limestone, are seen imbedded in it. The material is first sorted then washed, in which operation the earth, sand and stone are removed. The finely divided silt of the vats is dried, ground, or rather crushed between rollers to a fine powder. It is then packed for market. Work had been going on at intervals for two years, up to last July, when operations were suspended, in consequence of some business troubles of the party working it. Up to that time about 400 tons had been prepared, and most of it had been sold, giving good satisfaction and gaining the reputation of a superior article. From surface indications there is a strong probability that the deposit is of great extent.

WHITE CLAYS, FIRE–SAND, AND FELDSPAR.

The deposits of rich white clay about Woodbridge, Perth Amboy, South Amboy and Washington, are worked more and more extensively every year. Their quality is such that the demand for them is steadily growing, and they are finding their way to places more remote. Manufacturers of fire brick, of alum, of wall paper, of pottery, &c., find these clays to be of better quality and more accessible than any others in our country, and they will yet find them superior to many clays brought from abroad and sold at higher prices.

It is difficult, if not impossible, to get accurate statistics of the business done in this branch of our mining industry.

The geological map of the State defines accurately the limits within which this clay is to be found. It is in regular layers, and has a southeasterly dip, and underlies a large extent of country. The beds which have been opened are upon the outcrop of this formation, and are popularly thought to be of limited extent. In some cases the superficial drift material has cut away the clay formation and filled the cavities with gravel and sand. and in other cases has covered the clay with heavy bodies of earth, gravel and sand. Hence the necessity of testing the depth of the overlying earth, and the thickness of the layers of clay by boring. This method of searching is specially applicable in all the intervals where the ground is yet undeveloped. And even in the midst of the clay workings there has as yet been very little systematic exploration. To those interested, especially the owners of clay lands, a thorough exploration of their property may be of great value, and we refer them to the paragraphs on boring for clay, as the process is described on another page, for information upon this subject. The importance of this will be appreciated when it is understood that an acre of good fire-clay may yield from 10,000 to 40,000 tons—worth from $3 to $5 a ton.

The quality of our fine clays is unsurpassed. Many of these clay beds yield an article too rich in alumina, or too pure. They are adapted to the making of the finest wares, and it is a mistake to use them for inferior purposes, for which there is an abundance of material quite good enough. Nowhere else in the country is there such a deposit of superior clays, so easily worked, so accessible, and so near our large markets, and hence its national importance. In view of these facts, it should be more highly appreciated by capitalists and manufacturers. The careful sorting of choice portions and the removal of foreign matters by washing is almost unknown. In all foreign countries the clays for the finest porcelain ware are washed. This is done at a single locality only in New Jersey—at Mr. Such's banks, near South Amboy. By means of washing a pure article is obtained from an otherwise inferior clay. The matter should be looked into by our manufacturers and clay dealers.

Some of the more sandy clays dug near Woodbridge, do better than those which are richer for crucibles and glass pots. They burn without shrinking into a firm and solid mass. This is due to the sand mixed with the clay. A recent analysis by Dr. Pohlé, of New York city, of clay from William B. Dixon's pits shows 3 6-10 per cent. of titanic acid. More recently an analysis made in the survey laboratory of washed clay, prepared by George Such, of South Amboy, shows the composition of these clays and also the presence of titanic acid.

Washed FINE WHITE CLAY, *South Amboy. Sent by George Such:*

ANALYSIS.

Water,	11.95
Alumina,	38.69
Silica,	45.20
Sand (quartz),	.50
Per ox. iron,	1.31
Titanic acid,	1.25
Lime,	trace.
Magnesia,	.14
Alkali,	.30
Phosphoric acid,	.10
Sulphuric acid,	.44
	99.88

Whether this combination of titanium has any value is not known. Its presence in clay has not heretofore been much noticed, and its association with clays of this character is suggestive. Dixon's clay has been found to make the best of crucibles and pots for glass houses, and this may be in part owing to the large percentage of titanium present in it.

Associated with the clays there are quite large deposits of fire-sand, kaolin and feldspar, all of which have an extensive use in making fire-brick and sewer pipes. The latter of these substances, locally known as feldspar, is really a rotten rock, composed of quartz grains and white clay, with an occasional scale of mica. It resembles very closely some of our disintegrating gneisses of the northern part of the State, and is most probably the result of the decomposition of such rock. It is being more and more used in the fire-brick and sewer-pipe manufacture, and ought to be more appreciated than it is for making such articles.

SEARCHING FOR USEFUL PRODUCTS BY BORING IN THE EARTH.

The auger is available in all borings through strata or beds free from stone, and is, therefore, valuable in searching for clays, marls, glass-sands, peat, hematites, ochres, &c. In the southern half of the State there are scarcely any beds which cannot be penetrated by the auger, aided by a chisel or needle for breaking an occasional stone or layer of *hard pan.* It has been employed for many years in searching for clays about Woodbridge and Amboy, but too often these have been quite superficial, and often without any system. Hence the failure to get results of any value. A large area of territory embraced within the limits of the clay and marl formations has never been touched by the auger. Here, then, is a wide field for future explorations. The beds of marl are remarkable for their uniformity in thickness, strike, dip, and other features, as are, possibly, the beds of glass-sand and clay, while the overlying loam, gravel, sand, clay, &c., which are of more recent origin, are noted for the irregularities of their layers. It is, therefore, impossible to get any definite information respecting the beds they cover, except by digging or boring. But digging is slow and quite expensive. Boring scarcely disturbs the surface, is quickly done, comparatively cheap, and affords us correct knowledge concerning the strata penetrated. For this work augers of various patterns are in use. Generally an ordinary threaded auger with a bit, diameter from an inch to two and a half inches, is used. This is welded on to an iron rod, whose cross section may be square or circular. This is made to screw on a second rod, and that on another, so as to get any desired length. These rods are generally square, and about three-quarters of an inch on a side, but as a rule the size of the rods is proportional to the diameter of the bit. They may also be spliced together and fastened by a ring shoved down over the two lapping ends. Upon a rod thus constructed a handle is fitted so as to move up and down upon it, and to be fastened by a wedge at any desired point. By means of this the auger is turned, requiring, generally, two men. When the thread is filled the auger is drawn up and the material examined, so that every portion of the strata penetrated can be examined at the surface. Augers are rarely used at greater depth than forty feet, and in nearly all cases this is sufficient to test ground. At such depths, and even at twenty feet, the raising of the auger is a difficult matter, and then a windlass, or better a derrick, with a block and pulley, may be employed. Such a length of rod also requires guides to keep it erect, and for this purpose shear poles set up at the mouth of the boring are necessary. These may be of the same length or a little less than that of the rods. Sometimes strata of wet, running sands, or quicksands, are met with, and this fills the boring, and the auger makes no headway. To counteract this tubing must be used. Sheet iron pipes of the size of the bore are driven down to shut off the sand, and the boring is then resumed inside of the tube. Gravel or small cobblestones may be broken by a chisel-pointed rod, and then either raised by the auger or pushed to one side. Sometimes the bit is made convex, or spade-shaped, at the bottom. Equipped with these tools, two men can put down several twenty-feet holes in a day, or one (possibly more with favoring conditions), forty-foot boring. Of course, the location of the borings must be judicious. Side hills or sloping ground is always to be chosen rather than summits, or ridges, or flats. In Germany boring is an almost universal mode of searching for brown coal. The strata covering this are earthy, and are such as are readily penetrated by the auger, but the thickness of this covering often exceeds 100 feet. At this, and even greater depths, the auger is employed with success. In Saxony borings having an average depth of 120 feet, cost twenty-seven cents per vertical foot. There the augers are often made with a valve opening upwards to hold the material as it is loosened until raised to the surface. Pod augers, with a vertical slit, or a spiral slit, constitute another form. To break a stone or to push it aside, the bit is made double-edged, or a chisel borer or drill is let fall upon it. The diameter of the bit is sometimes as much as six inches, and then the rods are correspondingly large, and the working of them requires long levers at the surface and increased power. In New Jersey depths of 40 feet are in nearly all cases sufficient, as at greater depths the amount of top earth is too much to be moved, and subterranean mining would be too expensive. For this depth an auger two or two and a half inches diameter, with five-eighths inch rods, is sufficiently large The employment of this comparatively inexpensive mode of searching is earnestly recommended to all interested in the discovery of clays, marls, sands, or other valuable earthy deposits.

FERTILIZERS.

MARL.

The green sand marl continues to be used in large quantities for enriching our soils. The different marl companies are transporting it by railroad to places farther and farther off from the marl beds, and it is gradually proving itself a valuable fertilizer on all soils. Its effect on grain crops is not very striking, and on the better class of soils it does not show such surprising action on the growing crops as it did on poor and exhausted soils where first used. But persistence in its use finally shows its power to permanently enrich soils. Its best effects are seen upon clover and grass lands, though in the marl region it is most valued for growing potatoes. Its effects on corn and grain are secondary, it causing clover to grow, and clover making the corn crop.

LIMESTONE FOR LIME.

In the progress of the field work of the past season another outcrop of the pure or fossiliferous limestone (of the Trenton period most probably) was observed. It is on the farm of John Durling, two miles northeast of Johnsonburgh, and near the Sussex county line. This rock is seen cropping out on the western slope of a low ridge which runs parallel to the Johnsonburgh and Newton road, about fifty yards west of it. It can be traced for nearly a half mile on the line of its strike from northeast to southwest. On the crest and eastern slope of the same low ridge the magnesian limestone shows itself, while on the west, across a slight depression, there is a slate ridge. So that, geologically, its position is between these two rocks—which corresponds with the relations observed at all the other points where it has been seen. The most northerly outcrop here is in the road leading to Durling's house. No fossils were found at the time of our visit to this locality, but from the close resemblance of the stone to that quarried near Stillwater, and to that cropping out near Belvidere, at both of which there is an abundance of fossils, there is every probability that more careful examinations will be successful in finding them here also. A specimen of the best stone, as obtained from the surface ledges, was analyzed, and found to contain 1.6 per cent. of sand and foreign matters, 93 .23 per cent. of carbonate of lime, and a little magnesia. Some of the slaty portions of the ledges are not quite as good as the more crystalline specimen which was analyzed.

This fossiliferous limestone is also seen a short distance southwest of Newton. A specimen sent to the survey laboratory by William P. Nicholas, of that town, gave the following result on analysis, viz:

Quartz and insoluble matters, - - - - -	12.70
Oxide of iron and alumina, - - - - - -	1.60
Carbonate of lime, - - - - - - - -	84.90
Carbonate of magnesia, - - - - - - -	0.45
Total, - - - - - - - - - -	99.65

Localities and other analyses of this fossiliferous stone are given in the "Geology of New Jersey," pp. 131-133 and 396-399.

The white, or crystalline, limestones of the State are gradually coming into use for making lime, both for agricultural and building purposes, and everywhere with satisfactory results. One of these recently-opened quarries is that of the "Warren Marble Quarry Company," at Lower Harmony. This is properly a *marble* quarry, but the refuse stone is burned into lime at the side of the quarry. The lime from it has gained a good reputation, and some say that it is superior to the blue stone lime, as it makes a stronger mortar, and in large doses it does not "kill" the ground.

ROADS.

There is an increasing interest shown in the construction and repair of our roads. With a rapid increase of population, and the filling up of desirable locations with new comers, the value of good roads is seen in the higher price and more ready sale of adjacent lands. Wherever improved roads have been made, even if against the wishes of many people, and if paid for by taxes, they have at once caused the property affected to rise in price by a sum more than equal to the cost of the roads.

The graveled roads in all the southern half of the State, and in the country roads everywhere, are doing much to benefit the lands through which they pass. The turnpikes of this kind in Middlesex, Mercer, Monmouth, Ocean, Burlington, Camden, Gloucester, Salem, Cumberland, Atlantic and Cape May, are all successful, and have been of incalculable service to the districts they pass through, They cost from $1,000 to $3,000 a mile, according to the expense of draining, forming and graveling. It would be a great benefit to the State if some more general plan of laying out, constructing and repairing roads, could be put in operation.

In the northern part of the State Telford roads are exciting a good deal of interest. They are on trial in Newark, Orange, Bloomfield, Montclair, Plainfield, Elizabeth and Bergen Point, and are giving great satisfaction. They are made of broken stone, are smooth and solid in all kinds of weather, are very little subject to wear or damage, are easily repaired, not noisy, and are less expensive than any other stone road of good quality. The Essex road board has begun to lay out a system of roads for the county, in accordance with its business interests and its prospective growth. Spacious avenues are projected which shall start from Newark and radiate in nearly direct lines through the important towns and villages, and so on to the extreme borders of the county. The avenues to Springfield, Orange, South Orange and Bloomfield, are already constructed for several miles out from the city. They are covered with the Telford pavement, and are successful for the objects of the board and very popular.

We have an abundance of the best material for these roads in all the trap ridges of Central New Jersey, and there is not a doubt that every community that will use these materials in making hard and solid roads, will lay the foundation for substantial and permanent growth.

ON SOILS AND THEIR PRODUCTIVENESS.

It has been considered an important part of this survey to examine the soils of the State; to search out and describe our available fertilizers, and to make such investigations and suggestions in relation to agriculture, as may best call attention to our resources. The object of analyzing soils has been greatly misunderstood. It is supposed by many intelligent people, that if a soil is analyzed and its constituents set down, its deficiencies will at once appear, and that the farmer need only supply these and he will make a good soil. Unfortunately, this notion is not sustained by the experience of those who have tried to carry it into practice. Taken by itself it fails utterly. So differently are the important elements of good soils combined, and so various are they in their degrees of fineness and tendency to decompose, and also in their other physical properties, that their chemical composition gives only a small part of the information needed in order to judge of their productiveness. And so many attempts to draw instruction from the bare analyses of soils have failed, that a wide-spread impression prevails that soil analyses are useless. The true object of soil analyses is not so simple as the above hypothesis would indicate; neither is it so worthless as others have concluded. The characteristics of the soils in different parts of the country are distinctive. They are formed, to a large extent, from the rocks which underlie them, and so are classified in the same way with the geological formations upon which they lie. Analyses of these classes of soils will help to explain the peculiarities of their management and productions, and guided by their chemical composition the intelligent and skillful farmer will plan his rotation of crops, apply his manures, and manage his tillage, so as to bring out and to economize all the natural riches of the soil. As the intelligence and skill of our farmers increase, they will be able to profit more and more by knowing the composition of the soils they till. We have already reached the point where the analysis is made useful in guiding farm plans and practices, and it promises to do much more in the future. A large number of soil analyses are now ready for publication, and are only awaiting the preparation of the details of successful management and productiveness.

We have a warm and easily tilled soil, which responds most generously to high cultivation, a climate mild, salubrious and invigorating, and a location, in regard to markets, superior to any other of the United States. We have superior facilities for obtaining fertilizers with which to enrich the soil. A dense population and a mixed industry supply the highest possible stimulus to the farmer to improve his advantages, and to make the most of his means. To do this best there must be more skill, intelligence and enterprise put in the business. At the last session of the Legislature a law was passed to "organize a State Board of Agriculture," whose object should be to develop the principles, to improve the art, and to foster the interests of agriculture in New Jersey. This board is composed of the board of managers and the superintendent of the State Geological Survey, the president and two of the professors of the State Agricultural College, three members of the board of visitors of the Agricultural College, and the president or other representative of the State and county agricultural societies which may be in correspondence with the Board of Agriculture. This board met in September, and organized by electing Governor Parker president, and George H. Cook secretary, arranging business for a public meeting of the board, and adjourned to meet at the call of the president, in the State House, at Trenton, at some time during the coming session of the Legislature. Some papers and reports upon topics of interest to our farmers will be presented at that meeting, and business matters affecting the development and improvement of our agricultural resources will be discussed.

It may be worthy of consideration whether the matters relating to the analysis and properties of soils, which are now in charge of this board, should not be transferred to the Board of Agriculture, and there discussed in connection with those practical results which are reached by our successful farmers.

HUMAN BONES FOUND UNDER ROCK.

The Salem Standard says: "One day last week [in November] as the laborers were digging limestone, on the Amos Peasley farm, in Mannington, they came across the remains of an Indian at the depth of six feet below the level earth. The bones, it is supposed, were those of a warrior, inasmuch as several darts were found with the remains, it being the custom of the race to bury the implements of war with the deceased brave. The remains were not discovered until a greater portion had been thrown out with the stone, but those saved, though considerably broken, are in good condition; a part of the leg bones and of the teeth especially, being in almost perfect state of preservation. *They laid under a layer of solid limestone six inches thick, which must have formed since the remains were deposited there, perhaps hundreds of years ago.*" My friend David Petit, of Salem, sent me notice of the finding of these bones, and of their location in regard to the rock, as I have shown by italicizing part of the above quotation. On account of the interest expressed by students of geology upon all questions relating to the antiquity of the human race, it was thought best to visit the place where they were found, and to see the fragments that were preserved, and on exhibition at a store' in Salem. The bones were very much broken, and many of them were missing. There seemed to be no question but that they were Indian bones; there were three very perfect stone arrow-heads found with them; there was also a fragment of a prong of buck's horn, and a piece of bone 5 or 6 inches long ground to a point at one end. The bones were tender, and some of them much decayed; their color was reddish, and the small portions of earth adhering to them were of a bright salmon-red color. On the inside of the fragments of the skull some pieces of roots were observed closely adhering and fitting. They were about the size of a fine knitting needle, and evidently had grown and attached themselves to the bones while the latter were in their place of burial.

The locality where they were found is on the farm of James J. Petit, Esq., of Mannington, on the south bank of a small run which empties into Mannington creek. The bank is 8 or 9 feet high, and quite steep. It appears to be composed of sandy loam, but from 2 to 4 feet beneath the surface the light-colored limestone and lime sand of the marl formation is found in place. The formation in that place consists of nearly level layers of limestone, which are from 5 to 10 inches thick, and separated from each other by layers of lime-sand, which are from a foot to a foot and a half thick. Both these substances are of the same kind of carbonate of lime, and they contain the same kinds of shells and other marine fossils, and differ only in that one part has hardened to stone, while the remainder is still soft, like sand. The layers of limestone are not in an unbroken sheet, but are traversed by joints or fractures, which divide the stone into pieces of from a few pounds to a ton in weight. The bones were found six or eight feet back from the surface of the bank, and covered by 5 or 6 feet of earth. The men engaged in getting out this limestone, say they found the skeleton under one of these large flat stones, which appeared to be in its proper place among the others, though very near the edge of the layer. They did not notice the bones until they had thrown a good many of them out with the waste sand, the material in which the bones were being of an ochrey red color, more like the earth than like the light-colored lime sand.

I do not think there is any evidence that the limestone has formed since the bones were deposited there, or that there is anything extraordinary in their location, or the time they have been buried. The case is presented only to correct any misapprehension that may have been produced by the published statements.

J C Branner

GEOLOGICAL SURVEY OF NEW JERSEY.

ANNUAL REPORT

OF THE

STATE GEOLOGIST,

FOR THE YEAR 1873.

TRENTON, N. J.:
THE STATE GAZETTE—MURPHY & BECHTEL, BOOK AND JOB PRINTERS.
1873.

Ea.

GEOLOGICAL SURVEY OF NEW JERSEY.

ANNUAL REPORT

OF THE

STATE GEOLOGIST,

FOR THE YEAR 1873.

TRENTON, N. J.:
STATE GAZETTE—MURPHY & BECHTEL, BOOK AND JOB PRINTERS.
1873.

BOARD OF MANAGERS.

His Excellency JOEL PARKER, Governor and *ex-officio* President of the Board,	Trenton.
HON. ANDREW K. HAY,	Winslow.
CHARLES E. ELMER, Esq.,	Bridgeton.
HON. WILLIAM PARRY,	Cinnaminson.
HON. HENRY S. LITTLE,	Matawan.
SELDEN T. SCRANTON, Esq.,	Oxford.
HENRY AITKIN, Esq.,	Elizabeth.
HON. AUGUSTUS W. CUTLER,	Morristown.
ABRAM S. HEWITT, Esq.,	Ringwood.
WILLIAM M. FORCE, Esq.,	Newark.
THOMAS T. KINNEY, Esq.,	Newark.

STATE GEOLOGIST,

GEORGE H. COOK, - - New Brunswick.

To His Excellency Joel Parker, Governor and ex-officio President of the Board of Managers of the State Geological Survey:

SIR:—In accordance with the law authorizing the Geological Survey, I have the honor to submit my annual report on the progress and present condition of the State Survey, for the year 1873.

With high respect, your obedient servant,

GEO. H. COOK,
State Geologist.

RUTGERS COLLEGE, New Brunswick.
December 30, 1873.

REPORT.

The act of the Legislature authorizing the present Geological Survey of the State was passed at the session of 1864.*

A supplementary act authorizing its continuance was passed at the session of 1869.†

At the session of the Legislature of the present year, and in accordance with the recommendation of the Board of Managers another supplementary act was passed providing for its further continuance.

Under this authority the work has been continued through the past season, and the following persons have been engaged in different branches of the Survey:

PROF. JOHN C. SMOCK, *Assistant Geologist*, has been in active duty a part of the year, during which he has visited many of the iron mines, has pursued studies of the rock structure of the Highland Range of Mountains, and more especially of the rocks, ores and minerals of the Jenny Jump and Marble Mountain ranges.

EDWIN H. BOGARDUS, *Chemist*, has been constantly engaged in the laboratory analysing ores, minerals, rocks, soils and fertilizers, and in testing mineral substances sent by citizens, or collected for purposes of inquiry and investigation.

PROF. EDWARD A. BOWSER, *Engineer and Surveyor*, has been occupied a part of the season in making a topographical map of the country in which Jenny Jump and Marble Mountain lie, and in completing an examination of the monuments marking the boundary between New Jersey and New York. Wm. A. Chapman and Elbridge Van Syckel, Jr., graduates in the engineering department of Rutgers College, have assisted Professor Bowser in surveying and mapping the mountains, and James K. Barton, another graduate, has assisted him in surveying and mapping that portion of country about the Great Meadows of Warren county.

---

* The results of the Survey under this act were published in annual reports for 1864, 1865, 1866, and 1867, which were printed by the Legislature and distributed with the legislative documents and the Geology of New Jersey, an octavo volume of XXIV and 899 pages with a portfolio of 8 maps, which was published in 1869 by the Board of Managers of the Survey. See descriptive list of publications of the Geological Survey at the end of this report.

† The results of this continuation of the Geological Survey have been given in the annual reports of the State Geologist, printed by the Legislature in 1869, 1870, 1871, and 1872, and distributed with the legislative documents.

My own time has been taken up with the miscellaneous work of the survey—the drainage projects, the examination of the northern boundary line, the various departments of laboratory, field and surveying work, and in answering numerous and pertinent letters of inquiry. I have found great satisfaction in visiting some of the new iron mines, and in tracing out with Professor Smock the lines of division between several well marked belts of the Azoic rocks.

There is a great increase in the number of applications for information in regard to mines, minerals, mineral waters, ores, building stones, clays, sands, marls, and other natural products, which we answer as far as the time and means at our disposal will allow.

The work done is given in detail under the following heads:

1. The Drainage Works.
2. Survey of the Northern Boundary.
3. Subdivision of the Azoic region into four oblique belts, with a map of Northern New Jersey, and a Topographical Map of Jenny Jump Mountain, with its Iron Mines.
4. List of Mines of Magnetic Iron Ore, with notes.
5. Searching for Iron Ore.
6. Zinc and other Ores.
7. Building Stones.
8. Clays and Sands.
9. Limestones.
10. Marl.
11. Graphite.
12. Infusorial Earth.
13. Roads and Road Material.
14. Soils and unimproved Lands.

I.

Drainage of Lands.

The law to provide for the drainage of lands, which was passed by the Legislature of 1871, put the plans for draining tracts of wet and marshy land under the direction of the Board of Managers of the Geological Survey. It required them, "on the application of at least five owners of separate lots of land included in any tract of land in this State, which is subject to overflow from freshets, or which is usually in a low, marshy, boggy or wet condition," to examine such tracts, and if they judged it for the public interest, to survey, and make a plan for the drainage of the tracts, and to submit the same to the Supreme Court and ask for the appointment of commissioners to carry out and execute the works of drainage, and to assess, collect and pay the expenses incurred. Under this act your Board has prepared plans for the drainage of the tract of land subject to overflow, bordering the Passaic river, between Chatham and Little Falls, in Morris, Essex, and Passaic counties; and for the tract of land on the Pequest, in Warren county, between Vienna and the Sussex county line. Commissioners were appointed for each of these works, and they have entered upon their duties. These enterprises involve the interests and rights of a large number of persons, and the mode of proceeding to carry them out is new and untried. Hence the Commissioners have thought it prudent to proceed with great care—which of course, has required time. The securing titles to the lands and property which have to be taken for the widening of streams, the deposit of excavated material, or the lowering or removal of dams, has been the first work of the Commissioners; on the Pequest this work is done, and on the Passaic it is in progress. The work of clearing the streams might have begun this fall, but the financial difficulties of the country compelled them to defer it. They are of the opinion that the expenses of the work will be least burdensome to land owners, if instead of being assessed for full payment at once, they can be divided and paid in several yearly installments—and the Commissioners have prepared the draft of a bill for the purpose, and ask this Board to recommend its passage.

The completion of these works of drainage will add largely to the productiveness and wealth of the State, and will remove fruitful sources of insalubrity and sickness; and while a just compensation must be made for any property taken or injured, the expense will be so provided for as not to be burdensome to the land owners.

II.

The Northern Boundary Line.

The division line between New Jersey and New York is marked by monuments on the line, at the distance of one mile from each other. Some of these monuments have been destroyed, others are said to have been moved for fraudulent purposes, and it was judged expedient by your Board to have the line examined, after which, if found necessary, the State of New York can be asked to join in restoring it to its true place, and in establishing permanent and easily verified monuments upon it. The first thing to be done in this examination is to determine the true latitude and longitude of Carpenter's Point—which is the extreme western end of the boundary, and then to compute the precise bearing of the straight line from the western end to the monument at the eastern end, which already has its latitude and longitude determined. By running this line through with the proper bearing, the true condition of the monuments will be found.

In accordance with the directions of this Board I applied to Professor Pierce, Superintendent of the United States Coast Survey, to determine these particulars, viz., the latitude and longitude of Carpenter's Point, and the azimuth of the division line, for us, and have great pleasure in reporting that Professor Pierce consented to have the work done by the officers of the Coast Survey, and directed it to be begun at once. An assistant was sent to Carpenter's Point where he established an observatory, set up the necessary instruments, and spent almost the whole of May and June in taking observations from which to make the proper computations. The work of computation is still in progress at the office of the Coast Survey in Washington, and we are informed that it will be completed and reported to us by the close of the year. The enlightened liberality shown in doing this very nice and expensive work for us is worthy of high praise, and it is but just to give this public expression of it.

By the next meeting of the Board I hope to be able to report the condition and place of the monuments in relation to the straight division line.

III.

Subdivision of the Azoic Region into Belts; with a Map of Northern New Jersey.

The Azoic rocks of New Jersey are nearly all included in the mountainous district of country which lies in the northern part of the State, occupying the northwestern parts of Bergen, Passaic, Morris, Somerset and Hunterdon counties, and the southeastern parts of Sussex and Warren. Ramapo, Trowbridge, Mine and Musconetcong mountains, mark its southeastern, and Pochuck mountain, Pimple Hill, Jenny Jump and Marble mountain its northwestern border. This whole belt of mountain ridges is part of the chain of mountains which is known in New York as the Highlands, and in Pennsylvania as the South mountain.

The extreme length of this region from the Delaware on the southwest to the New York boundary line, on the northeast is sixty miles; its breadth at the Delaware is ten miles, and at the New York State line is twenty-two miles, and its area is about nine hundred square miles, exclusive of several tracts of country which though included in the above boundaries are underlaid by newer rocks.

In this whole region very little bare rock is to be found. Almost everywhere it is covered with a heavy body of drift earth, and much more than half of it has the surface thickly strewn with loose rocks and stones. This condition of the surface has rendered it much more favorable for the growth of wood, than for cultivation; and a large part of it is in forest.*

---

* That portion of the Azoic region embraced within the limits of Sussex, Passaic and Bergen counties, and that part of Morris county north of the Morris and Essex Railroad has 83 per cent. of its area in forest. Morris county south of the same road and Hunterdon county north of the Central Railroad of New Jersey have 39 per cent. in forest. Warren county and that part of Hunterdon south of the Central Railroad have 45 per cent. in forest. Taken together the area covered by forest is a little over 60 per cent. of the whole.

On this account it has been found extremely difficult to make any clearly defined and easily understood subdivision of this formation. The difficulty is still further increased by the peculiar circumstance that while the whole belt or strip of Azoic rocks crosses our State in a general direction of north fifty degrees east, the *strike* of the rocks, which is only the direction of the upturned and exposed edges of the strata is about north forty-three degrees east. So that any natural subdivision of the Azoic formation of our State must be into narrower belts which cross the whole formation obliquely and come to an end in the blue limestones on the northwest border of the region, and in the red sandstones on its southeastern border. The Hudson river cuts through the Azoic formation from Stony Point to Cornwall, and the rocks are finely exposed for study, but if one were to examine them with the expectation of learning the character and structure of New Jersey rocks of that age, he would be entirely at fault; for the Hudson river section mainly exposes a single one of the four belts into which we now divide our Azoic rocks. In the same way the Delaware cuts through the formation, but it only exposes two of the four belts into which the rock is divided.

BELTS.

For convenience of reference, the following provisional names have been given to these belts; and they are put down in the order of their occurrence beginning with that on the southeast and, going on to the northwest; and in any descriptions of a single belt, the southwest points are named first, and those further towards the northeast in succession.

1. The Ramapo Belt.
2. The Passaic Belt.
3. The Musconetcong Belt.
4. The Pequest Belt.

1. *The Ramapo Belt* begins near Peapack, in Somerset county, and extends on in a northeast direction by Pompton to the State line, and in the State of New York to and beyond the Hudson.

It is about two miles wide at the southwest end, and at the State line its width is five miles. Mine mountain, Trowbridge mountain, Watnong mountain, the isolated low mountains between Denville and Boonton, the mountain ridge extending from Boonton to Pompton, and the Ramapo mountains are all in this belt. Its southeast border is characterized by its meeting the red sandstones and conglomerates of the Triassic Formation, and its southwest end is likewise in these rocks. Its northwest border is marked by a characteristic white crystalline limestone containing serpentine in grains, large masses, and fibrous forms as chrysotile. An outcrop of this limestone is to be seen at the Sanders property, a mile from Mendham, on the right of the road to Morristown; another is a mile and a half north of Montville, where there are quarries of limestone; still another is about two miles northeast of Bloomingdale, and a half mile west of the Wynokie road, on the DeBow property; farther on, limestone crops out at the west foot of Windbeam mountain at the roadside, near G. Monk's house; and again on the side of the road from Boardville to Greenwood lake, and a half mile from the former place; further on, in the tunnel to the Old Blue mine, at Ringwood a bed of limestone is cut across; and near the State line and just west of the road from Ringwood to Sterling limestone is found in small quantity; further on, in New York, in the extension of the same line, it is found a quarter of a mile east of the northeast end of Truxedo pond. Other outcrops of limestone are seen east of the road at Wynokie, on Mr. Rhinesmith's land, and at Boardville, near the dwelling of J. W. Schermerhorn. But after examining the country, it was thought best to draw the division line along the most westerly of these outcrops of limestone, and to consider it all as belonging to the Ramapo belt. The line is drawn on the map between these outcrops, according to the best of our judgment now, though further examination may lead to its being slightly changed.

The Passaic Belt is the next belt on the northwest, and the line just described, is its southeast boundary. It begins at Clinton, in Hunterdon county, at the southwest, and extends on by

Dover and Ringwood to the State line, and beyond to Stirling and Turner's Station, where it ends. Its breadth is nearly uniform, and about five miles. Its surface is high and undulating, but it has no conspicuous mountain ridges or elevations, and its hills have only local names. On its southeast border from Peapack to Lebanon, it is bounded by the Triassic sandstones and conglomerates; nearer Clinton, it is limited by the Magnesian limestone; and at its southwest end, at the valley of the South Branch of the Raritan, and of Spruce run, it is lost from sight under the Triassic rocks. Its northwest border is defined by a continuous valley through its whole extent. This valley begins at the Spruce run, above Clinton, where its first eastern branch comes in, and follows up the valley of that branch, and over the depression of the ridge at its head, into German Valley; and up that valley to Naughtrightsville, Bartleyville, Flanders, Succasunny, Berkshire Valley, Longwood Valley, Petersburg, Newfoundland and West Milford, to Greenwood Lake and the State boundary. Beyond this it continues on, by Bellevale to Monroe, in New York. This valley contains Potsdam sandstone, magnesian limestone and Hudson river slates, throughout its whole length: and, from Flanders on to the northeast, it is characterized by extensive ridges of Green Pond mountain conglomerate. No crystalline limestone has been found in this belt, but it is remarkable for its rich mines of magnetic iron ore.

3. *The Musconetcong Belt*, is northwest of, and adjoining the Passaic Belt. The valley just described is its southeast boundary, as far as it goes to the southwest. From the Spruce run to the Delaware, it is bordered, principally, by red sandstone rocks, or as at Little York by magnesian limestone, or as at Amsterdam by quartzose rock. The southwest end is at the Delaware, where it descends to pass under the river, and in Pennsylvania it extends on to near Reading. Its northwest boundary is marked, as it runs from the Delaware by Lower Harmony up Harker's Hollow, and over the mountainous divide near Mount No-More to Oxford Furnace; thence, up the valley of the Pequest to Vienna, and then up Bacon's creek to War-

renville and Allamuchy; along the east foot of Allamuchy mountain, and east of the Cranberry reservoir, and the Roseville iron mine, to the high dividing ridge between the streams running into the Musconetcong, and those running into the Wallkill; from this divide it descends into the Wallkill valley, and follows along the east border of that valley by Franklin, Hamburgh, Vernon, and on to the State line. Musconetcong, Pohatcong, Schooley's, Hamburgh, Wallkill and other mountain ridges are in this belt and a large portion of it is an elevated table land. It continues quite across our State and ends near Newburgh, in New York, and near Reading, in Pennsylvania. In breadth it is from six to eight miles, including several long and wide valleys underlaid by magnesian limestone. No crystalline limestone has been found in it, in which respect it differs from the belt next adjoining on the northwest.

4. *The Pequest Belt*, includes all the Azoic rocks northwest of the boundary just described. It extends quite across the State, but on the northeast it passes only a few miles beyond the State line, and in Pennsylvania it ends a few miles northeast of Bethlehem. Its northwestern edge is everywhere overlaid by Palaezoic rocks. Scott's mountain, Marble mountain, Jenny Jump, Pimple Hill and Pochuck mountain are in this belt. It is very irregular in width, being entirely lost in some parts of its length, and widening out to three miles or more in others. Crystalline limestone is very abundant in this belt, and it is also characterized by its rich zinc mines, and by its iron ores containing manganese.

AGE OF THE ROCKS.

In this division into belts, we have not been able as yet, to find any means of identifying our Azoic rocks with either the Laurentian or Huronian rocks into which the Canadian geologists have divided theirs.

The rocks of the Pequest belt have most resemblance to the typical Laurentian rocks of Canada, and the Green Pond mountain conglomerates have many characteristics in common with the

Huronian rocks of the Canadian geologists. There is a peculiar bluish gray slate which crops out in the bed of Ringwood river, just on the upper side of the bridge at Pompton, and has been found in one or two other places on the southeast border of the Ramapo belt, which is identical in appearance with the Huronian slates of Canada, but any positive conclusions would be unwarranted in the present state of our knowledge.

Structure.--The structure of the rocky materials of this formation has been given with many illustrations in the "Geology of New Jersey," and for full details reference must be made to that work. It is sufficient to say here, that all the rock of the formation is stratified; that the strata are not horizontal but are highly inclined, and in some cases vertical, that inclination which is called the *dip* is, with some exceptions, towards the southeast; that the direction of the edges of the upturned strata, called the *strike* of the rock, is northeast and southwest. The accompanying map shows the location and general direction of these rocks and their subdivision into belts, and gives at a glance what pages of text cannot convey.

Though the dip is usually in one direction, and that to the southeast, it has been found in mining explorations that the strata do not continue on downwards in the same direction of dip always, but that in many cases they bend round in a fold and return to the surface again; that in fact they are folds, and the parallelism of the layers is caused by the two sides of the fold being pressed powerfully together. The axes of these folds, or the lines about which they have been bent are not usually horizontal, but are much inclined from twenty-five degrees to fifty degrees to the horizon. This inclination of the axes of folding is always downwards in the direction of the strike towards the northeast. This inclination is, among our miners, called the *pitch*. The strata are not perfectly even and straight in their strike, but are commonly wavy, and instances are occasionally found in which the strike is changed from its usual northeast and southwest direction to one northwest and southeast, as if, in addition to being compressed on the sides, the strata had also been subjected to a powerful compressing force between their two ends, which had caused them to shorten in their length by bending sidewise around vertical axes and forming a curve somewhat like the letter S. In addition to these folds and bends, the rock is broken across in various directions by vertical cracks or *joints*, and it is not uncommon to find that the rock layer on one side of a joint has been moved away from the corresponding layer on the other side, and that they are now separated by an interval or *offset* of greater or less extent, amounting in some instances to a hundred feet or more. The direction of these offsets does not conform to any known law, but is in some cases in one direction and in others directly opposite.

The beds of rock are not uniform, some being very thin and others thick and massive. Sometimes the same bed is found to vary much in thickness, being many feet thick in one part and thinning out to almost nothing in others—this is specially true of the iron ore beds.

Rocks.—The greater portion of the Azoic rock is *syenitic* gneiss, being composed of crystalline grains of quartz, feldspar and hornblende, like syenite, and being stratified like a true gneiss. Mica is found in it in some parts, but it is not abundant, and in many layers of the rock it can not be found at all. Feldspar, which is the most abundant mineral in the rock, varies much in color; in some strata it is white, in others flesh colored, and in others bluish or grayish white, and it imparts its own shade of color to the whole rock. It varies remarkably in its power of resisting decomposition. In some places the rock appears solid and incapable of decay, while in others the feldspar has decomposed, and become chalky in appearance, and soft and earthy in its substance.

Hornblende is very abundant in some beds of the rock, and imparts its own characteristic black color to the mass, and in some cases it has been mistaken for iron ore by explorers. It has been fancied that this kind of rock has some connection with the beds of magnetic iron ore, but its true relation in that respect is not yet demonstrated. Like the feldspar it is found much decomposed in some places, and the material produced by its decomposition is remarkable for its deep reddish yellow color.

In some localities the stone splits freely and can be dressed well under the hammer, while in others the rocky mass is too hard and stubborn to be worked to any advantage. Localities of this rock can be found along any of the railroads crossing it, and great quantities are taken out of some of the iron ore mines. Quarries have been opened at Bloomingdale, Charlotteburgh, Franklin, Dover and Port Murray. Some beds of the rock are so peculiar as to be identified in hand specimens; but generally there is so much uniformity that hand specimens from the different belts and from different localities cannot be locally identified.

White crystalline limestone is found in the Ramapo and Pequest belts. That in the latter is in large quantity, and is interesting for its many and useful applications in agriculture and the arts, as well as for its rare and beautiful minerals. It is in such extensive beds that it is marked on the accompanying map by color, and it has been fully described in the "Geology of New Jersey." The white crystalline limestone of the Ramapo belt is not so well known, and is in much more limited quantity. It is remarkable for containing serpentine everywhere, and in some localities in such large proportion as to be almost worthless for making lime. The localities at Montville and at the De Bow property near Winokie are interesting to the mineralogist on account of the beautiful specimens of fibrous serpentine or chrysotile found in them. The massive serpentine is also very pure and handsome. Montville has long been famed as a locality for these minerals, but Winokie has not been heretofore noticed for them, though it has specimens quite as fine as those at the former place.

Magnetic iron ore is also found in regular and conformable beds between the layers of gneiss or limestone. The only difference between this ore and the other rocks among which it is found, is, that its beds are limited in extent, either thinning out or gradually changing in character until the ore is entirely replaced by rock—though this may not occur in hundreds or even thousands of feet. The mineral is easily recognized by its being attracted by the magnet, and some specimens are themselves magnets. Its powder is black and it has the color and lustre of iron. In some beds the ore is granular and crumbles so much as to be called shot ore, while in others it is extremely tough and hard. It contains some rocky impurities mixed with it in variable but small quantity, such as quartz, hornblende, feldspar, phosphate of lime, titanic acid, iron pyrites, &c.

Origin.—The rocks of this formation are now conceded by all geologists to be of sedimentary origin. They were originally deposited from water as sand, earth, clay, shells and corals or marl, and oxide of iron. Under the influence of pressure and heat, long continued, these deposits hardened to stone or rock. Under the prolonged and powerful influence of the same agencies the rocks were forced from their original horizontal position, turned up, bent and folded as we now find them, and the material of the rocks separated into distinct minerals, and changed from its earthy appearance to the crystalline structure which it now has. Examples to illustrate the possibility of these different changes might be cited, but they would hardly be in place in this report. In regard.to the iron ore however, it may be said that we have in New Jersey deposits of yellow oxide of iron now going on ; that they are in wet places, and are limited in the areas they cover. I have, in one instance at least, had a fossil from the northern part of the State of which the centre was red oxide of iron and the outer and main part was magnetic iron ore. Along our own shores too, we are having changes of level decided enough; and we have only to imagine them continued long enough to put our present level grounds in just as inclined positions as the Azoic rocks now have.

Description of the Geological Map.—This map is prepared specially to show the crystalline or Azoic rocks of the State, and the location of the different belts of those rocks, and the ranges of the iron ore mines. But it is also of general interest, and a short account of what it shows is accordingly presented. It is on a scale of two miles to one inch, and all the cities, towns and villages of the northern part of the State are on it, also the roads, railroads and canals. There is no attempt at shading the hills or mountains, but the high and low surfaces are to some extent shown by the location and direction of the streams, which, of course, must always be on the lowest ground, and their small branches must always descend from the higher to the lower places. The colors on the map are mostly lithological in their indications, some approaching the true colors, and others being only conventional. The crystalline or Azoic rocks are indicated by the crimson lake, gneiss being colored full, serpentine with horizontal bars, and limestone of a purple color, made by crimson underlaid by blue. The iron mines are full black. The sandstones and quartzose conglomerates by a brown or umber color, numbers being used to designate those of different geological ages, and a much deeper shade of the same being used to show the trap rocks. The limestones by a cobalt blue color, and of different shades for those of different ages. The slates are of a gray color, and are also shaded to show different ages.

The columnar section on the west side of the map shows the different geological epochs of the New Jersey rocks, arranged in order, the oldest being at the bottom, that next to it immediately above, and so on to the topmost, which is of the present time. The rocks in their natural places are not, however, as level and regular in their order as this section would seem to show, but are found lying at all the different angles of elevation, and in some places many of the rocks in our series are wanting. The Azoic rocks are the oldest in our series, and the sandstones, limestones and slates which occur on the northwest side of them, are of the palaezoic age, being the oldest of the fossil-bearing rocks. Those nearest the Azoic are the oldest, and those farther off are newer, the rocks dipping to the northwest. The rock on the southeast side of the Azoic is of the mesozoic or secondary age, in the series of fossil-bearing rocks. The dip of this rock is towards the northwest. The other rocks shown on the columnar section do not occur in Northern New Jersey, but are found in the middle and southern parts of the State.

From this it will be seen that we have rocks of all ages, except the coal bearing or carboniferous. The accompanying section across the State, from Dingman's Ferry, on the Delaware, to Jersey City and the Hudson river, exhibits all the large rock formations found in Northern New Jersey, in the same relations to each other in regard to location and direction of dip, which they really have. The elevation of the country above the sea level is also shown. The iron mines are marked upon the map in their proper places. The location of these is very interesting to those looking for new mines. The exhibition of the tracts in which no mines are marked, together with the ranges of those now in operation, must stimulate to greater and better directed efforts to explore the, as yet, undeveloped districts. The color of the limestone marks the localities of that rock plainly, and the lines of railroad show how both iron ore and limestone can easiest find their way to market.

IRON MINES.

The iron ores of the Azoic region have been mined almost ever since the English settlers came into the State. Governor Robert Morris had iron works at Tinton Falls, Monmouth county, in 1685. The Dickerson mines at Succasunny, Morris county, were bought in 1710; and a forge was in operation at Whippany, in the same county, in 1716. There was also a forge in Upper Freehold, Monmouth county, in 1716. The Oxford furnance, in Warren county, was built in 1742; and furnaces and forges near High Bridge, Hunterdon county, in 1754. Ringwood furnace, in Passaic county, was built in 1762; and those at Charlotteburg and at Long Pond, in the same county, in 1763. Numerous other forges and some furnaces were in operation before the Revolution. The amount of iron made must have been small, though no statistics of the production are now at hand. Morse's Gazetteer for 1821, says that two thousand five hundred tons of iron were then made yearly in New Jersey. Gordon's Gazetteer, in 1831, puts our annual product at one thousand six hundred and seventy-one tons of pig iron and three thousand tons of bar iron. At that time the iron was reduced from our ores by charcoal made in the vicinity of the works. With the application of anthracite coal to the reduction of iron ore, which began soon after this, and the opening of canals and railroads to furnish abundant and cheap transportation, the mining of our iron ores increased rapidly. Dr. Kitchell, in 1855, estimated the whole amount of iron ore mined in northern New Jersey that year, at one hundred thousand tons, In 1864, the estimate made for our annual report was two hundred and twenty-six thousand tons. In 1867, the estimated product was two hundred and seventy-five thousand tons. For 1871, the estimate was carefully prepared, and its result was four hundred and fifty thousand tons. The amount of iron ore mined in northern New Jersey in 1872, according to the returns obtained, was six hundred thousand tons. The amount mined the present year, as estimated from information furnished by the transportation companies and by individuals, is:

423,682	tons carried on the Del., Lack. and Western R. R.
196,000	" " " Morris canal.
13,970	" " " N. J. Central R. R.
27,000	" mined and worked at Oxford.
5,000	" " " " Ringwood.
665,652	tons total product of New Jersey mines in 1873.

The value of this ore at the mines is not less than $5 a ton, or $3,328,260.

LIST OF IRON MINES, WITH NOTES.

The description of new mines and notes upon the older ones as here given are not complete in any of the features enumerated, but only notices of the mining operations of the past few years, particularly since the publication of the "Geology of New Jersey" in 1868. An attempt is made to mention all the new mines and ore localities, and to note any important changes in the development and working of those described in that report. This enumeration is necessarily incomplete, owing to the extent of the field to be traversed and the large number of localities to be visited. As here given this is two hundred. To collect personally at all of these the data necessary for a detailed and accurate description, is not possible in a single season of field work. The plan pursued has been to study a district or belt, rather than attempt to go over the whole. This will explain the degree of fulness in some of these notes and the brevity in others. Wherever the localities have not been visited within the past two years, the needed information has been sought from persons acquainted with those points. And the description wherever based upon such information states the fact, so that in most cases it will be possible to discriminate between what has been obtained personally on the ground, and what has come from others. It is believed that this enumeration includes all the localities which can be properly styled *mines*, and nearly all the points at which much work has been done in searching for ore. In the notes on the working of our mines, the stoppages owing the late financial disturbance, are not given, but only those due to lack of transportation, quantity of ore, or other causes more properly belonging to such geological notes, rather than to a business directory. Nor has it been within the scope of this report to make full notes on the mineralogical features or lithological characters of the rocks, in consequence of a lack of time just now for the preparation of such descriptions, and because of the difficulties attending the whole subject of rock classification. The results of such a study will be reserved for a future and final report on the Azoic formation of the State. The geological features have been made prominent almost to the exclusion of the mineralogical. These statements will explain any errors and some omissions incident to such brief notes. They are put before the public in the hope that together with the accompanying map they may help to solve some of the perplexing questions of iron mining or searching for ore, or suggest new lines and localities that may develope into working and profitable mines.

The order of arrangement in these notes is based upon the subdivision of the iron ore district into four belts, running across the State from southwest to northeast. The boundaries of these subdivisions are given on a preceding page, and they can also be seen, together with mines and ore localities, on the geological map of Northern New Jersey accompanying this report. Beginning at the southwest end of the eastern or *Ramapo Belt*, the several mines are described in order, going towards the northeast to the State line. This is followed by the *Passaic Belt* in the same order, from southwest to northeast, and the grouping is geographical, by townships, rather than by ranges. The same order is observed in the description of mines in the *Musconetcong* and *Pequest Belts*.

MINES OF THE RAMAPO BELT.

SOMERSET COUNTY.

Bernardsville.—Ore was discovered and considerable digging done upon two or three farms near Bernardsville, Somerset county, in 1871. This was done by John Webb, of Chester. Since it was first opened but little has been heard of it, and it has not been visited a second time. The present lessees are parties in Dover. The New Jersey West Line Railroad, now running to Bernardsville, offers an easy outlet for ore.

Janes Mine on Mine mountain, has not been worked in many years.

MORRIS COUNTY.

Connet Mine.—This mine was opened in 1869 on an old tunnel near the Whippany river, on the farm of Stephen Connet, Water street, Mendham township, Morris county. The old adit or tunnel starting near the river penetrated the hill a distance of two hundred feet, and was probably driven in search of copper ores. In reopening the mine this tunnel was followed to the vein and then the latter was followed in a southeast direction about three hundred feet further, where the drifting was stopped in consequence of the ore diminishing so much in breadth that it was not profitable to work. Below this tunnel a second drift has been worked in a southeast direction, on the course of the vein, and has reached a point nearly five hundred feet from the surface of the hill at the old adit-tunnel mouth. Throughout this distance the strike of the vein is southeast, the dip towards the southwest at an angle of forty-five degrees and the *pitch* of the *shoots* of ore is towards the southeast. In this direction of the strike and dip the vein is an exception to the usual mode of occurrence of ore-veins in this State. This unusual direction is probably of limited extent, and further openings may show a curve around towards the east, and ultimately towards the northeast, the usual strike of rocks and ore-veins in the Azoic formation. The width of the vein varies from four to seven feet, between rough and irregular walls. Near the surface the ore was very much altered by the decomposition of its constituent minerals, and hence had to be washed to remove the earthy matter. In places there is some hornblende and a little pyrite. The rock of the walls is a dark colored hornblendic gneiss with irregular masses of pyrite scattered through it. In the vein the pyrite is most commonly in the hornblendic portions. The tunnel serves for drainage and for the removal of the material mined. The product has averaged three to four hundred tons per month, and this has been shipped from Morristown for the Musconetcong Iron Works at Stanhope.

Taylor Mine.—On George Taylor's farm, near his residence, east of Mine Ridge and near Taylortown. This is an old locality which W. S. DeCamp reopened the past season. He found a vein from two to three feet wide of rich ore—striking nearly east and west. About fifteen years ago three hundred tons of ore were taken out and sent to Ringwood. None has yet been shipped from the last work done by DeCamp.

Kahart Mine.—In Pequannock township, east of the Bloomingdale and Boonton road and about three miles from Bloomingdale. The old mine-holes are close to the road leading to Pompton Plains and on the crest of a low ridge. The ore from these old workings is very rusty, and has a large amount of pyrite quite uniformly scattered through it. From these openings a small vein of sulphurous ore can be traced northeastward following the trend of the ridge and near its crest line. The dip of the strata which crop out on this ridge shows everywhere a moderately steep dip towards the northwest. This direction of the dip is rarely seen in the gneissic strata of New Jersey, and this feature gives the locality more than ordinary interest, considered geologically. In addition, this locality merits particular attention as the first, and so far, the only place where the diamond drill has been used in searching for iron ores in our State. The work was done during the past summer by a drill from the American Diamond Drill Company, of New York, under the direction of J. W. Hussey, of Bloomingdale. Two veins were discovered; one, three feet thick, the other from three to six and a half feet. And on the latter a shaft sunk twenty feet found the thickness to average four feet. Further development of the property was stopped by the financial crisis in September last. Samples sent to the Survey Laboratory from this shaft were found to contain

52.34 per cent. of metallic iron,
0.17 " " phosphorus,
1.23 " " sulphur,
1.40 " " titanic acid,
21.20 " " rock.

The percentage of phosphorous is low and that of the sulphur is not large.

Lanagan Mine.—About two miles northwest of Pompton Plains village and near the southeast border of the gneiss rocks, there are several shafts in which lean ore has been found. As there was no work doing when visited nothing definite was to be learned. Judging from the surface a great deal of prospecting has been done.

De Bow Mine.—South of the last mentioned workings and on the adjoining property, there is a long line of attraction, which was opened last year by De Bow and Barnes. The results of their work were not learned.

Jackson Mine.—(Pompton Mine of the "Geology of New Jersey"), one mile west of Pompton church and a few rods south of the Bloomingdale road. This was reopened and worked during a portion of the past year by the lessees, Sutherland and Axtell. The vein is small and much disturbed by a coarse crystalline granitic dike which was struck in the main shaft. About five hundred tons of sorted ore had been mined when visited in July. The rock of this dike includes magnetite as one of its mineral constituents, together with feldspar and quartz. The attraction is strong over a wide area on the strike of the strata, which is towards the northeast. Over most of this ground, the south or negative end of the needle is affected.

The composition of average ore from this mine is here given,

Silica,	9.80
Magnetite,	73.15
Alumina,	9.48
Lime,	1.46
Magnesia,	0.72
Phosphoric acid,	0.54
Titanic acid,	4.40
Sulphur,	0.06
	99.62
Metallic iron,	52.96
Phosphorus,	0.23

The unusually large percentage of titanic acid is noticeable.

Ryerson's De Bow Mine.—One hundred and fifty yards south of the Pequannock river and at the foot of the gneiss ridges, on the west side of the Plains. This, too, is an old mine locality, at which additional explorations have been carried on during the year by Martin J. Ryerson, of Bloomingdale. In a shaft about twenty feet deep the ore was found nine feet wide and dipping towards the southeast. With the ore a little pyrite was observed, but this is said to be rare in the ore at the bottom of the shaft. Hornblende also accompanies the ore, but not in sufficient quantity to make it at all lean. The attraction at the shaft and for one hundred feet on the strike of the vien is strong and positive. Two trial pits southwest of the shaft uncovered a lean ore. The Bethlehem Iron Company hold this property under a lease from Mr. Ryerson.

Kanouse Mine.—This old mine, at the foot of Ramapo Mountain and east of Wynokie, has been reopened and worked within a year, but was not in operation when visited last summer. There are four shafts in addition to some surface diggings. The vein dips towards the southeast and the ore is very hard, compact, close-grained and mixed with a very white sulphide of iron—probably marcasite. A New York company own the property. The geological features of the locality are interesting, as close to the vein there is a crystalline limestone outcrop containing a large percentage of serpentine, and joining this, in immediate contact with it, and conformably stratified with it, is a greyish gneiss, traversed by numerous small quartz veins.

On the broad and elevated Ramapo Mountain range, belonging in this belt, the only mine which has been worked or which can be designated as such, is the *Butler Mine.* Local attractions are reported, but no explorations beyond the use of the compass have been made.

In this belt, beyond the State line, the following mines have been opened, viz.: *Hogencamp*, *Pine Swamp*, *Sure Bridge*, *Harris*, *Greenwood* and *Bradley*, near the Greenwood Iron Works, and the Forest of Dean Mine—all in Monroe township, Orange county, New York.

MINES OF THE PASSAIC BELT.

HUNTERDON COUNTY.

Large's Mine.—Round Valley, Hunterdon county, southwest of Lebanon and west of Round Valley, J. K. Large, of White House, has done much work in searches for ore. One shaft is ninety-five feet deep, showing a vein of mixed ore and rock six to eight feet wide, between walls which run east and west, but not ore enough for profitable mining. In some of the trial pits on this property the strata were found having a northwest and southeast strike—the lines of attraction having the same course. The attraction is not, however, anywhere very strong. In several of these holes the ore was found to be in thin layers or strings which ran out below. At one point the ore appeared to be entirely replaced by black hornblende, while the walls continued their regular course and dip. In all of them the rock for several feet down was very much disintegrated and crumbling from the decomposition of the feldspar and hornblende.

High Bridge.—The old mines here have been steadily worked by the Thomas Iron Company, yielding several thousand tons of ore yearly. Southwest of the old workings a continuation of the vein was uncovered on lands of Mr. Creagor, and a considerable amount of ore taken out by J. K. Large, of White House. The mining was driven up to the old company's line. During the past year the High Bridge Iron Company has been at work here—mainly in the way of exploration.

Old Furnace Mine.—On the farm of H. H. Creamer, near Beaver brook, in Clinton township, about two miles east of High Bridge. A great deal of work was done here about a hundred years ago for supplying in part the old furnaces of this neighborhood. About four years since this vein was opened on the adjoining farm, belonging to G. N. Alpaugh, by J. K. Large and Isaac Hummer, and afterwards worked by the Union Iron Company of High Bridge. The vein was found to be large in fact no clean foot wall was reached. On the hanging wall there was a string of rich ore—in places widening to three feet. The ore contained a large percentage of sulphur. The main shaft was about eighty feet deep, and from this the vein was opened by several drifts, so that the surface was thoroughly tested.

Cokesburgh Mine.—On the farm of O. W. Farley, three hundred yards east of the village of Cokesburgh, Tewksbury township, Hunterdon county. The history of this mine is very similar to that of the Old Furnace mine, having been opened before the Revolution, and again, about ten years ago by Hummer, Large and Conover, and afterwards, in 1872, by the Union

Iron Company. Here the ore was very rich and with only traces of sulphur, but the vein was so small, (from ten inches to two feet wide when stopped), and the quantity of water to be pumped so great, that the mining was unprofitable. The ore was very much liked by furnace men and commanded the highest market price.

Fox Hill Mine.—This is of so recent a date, having been opened in November, that it may be premature to dignify it with the above title. The diggings are on the lands of Henry Fisher and George Sutton, near a tributary of the Rockaway creek, and about three quarters of a mile south southwest of Fox Hill M. E. Church. There are several holes on the Fisher property, but when visited a few weeks ago, these were so filled with earth and water that the extent of the ore was not made out. In an adjoining field on Sutton's farm a shaft then sinking had struck ore of very good quality. The attraction is said to be strong and steady for a long distance and a great breadth of ore is reported as having been uncovered in the Fisher openings.

Pottersville Openings.—In the vicinity of Pottersville three distinct veins have been worked within the past two years. The first to be described is on the lands of Potter brothers, about one mile west of the village and near the Fairmount road. Here a vein five feet wide, between hard and firm walls, and running east and west with the hill, has been opened about fifteen feet deep, and about one hundred tons of good ore taken out. As it is about two hundred feet above the brook the drainage by an adit at the foot of the hill will be easy.

Another opening in this vicinity is on lands of J. V. P. Bartles, about half a mile northwest of the village and near the Fox Hill road. This vein is said to be five feet wide and the ore of good quality. The locality was opened by S. W. Seals and others, and has recently been sold to other parties.

MORRIS COUNTY.

Northeast of Pottersville about half a mile, and near the

Chester road, the Dover Iron Company did considerable work on a small vein of very good ore. This was stopped about a year ago.

About two miles west of Pottersville a vein is reported by the Dover Iron Company, but its exact location is not known, nor the results of their explorations.

Rarick Farm.—About a mile southwest of Hacklebarney and a few rods east of the road leading to Fox Hill, parties are now digging and finding ore. The work is not far enough advanced to write more with any degree of certainty. Northwest of this road and west of the Rarick diggings, a line of attraction is being tested by L. W. Langdon, of Chester, on what has been known as the *Pitney Farm*.

Hacklebarney and Chester.—Since 1868 the mining operations between these two points have been very greatly expanded. The old mines have been vigorously worked, and discoveries of great extent have been made. Much of this increased activity has been due to the completion of the Chester Railroad and its extension southward towards the Hacklebarney mines. The building of the projected High Bridge and German Valley Railroad will offer another and more direct outlet towards the Lehigh furnaces, and no doubt stimulate to still greater production. The capacity of these mines is very great and with cheap transportation they can furnish an immense amount of ore, considerable of which is sufficiently pure to be used for Bessemer steel.

The mines of this district appear to be nearly all in two lines or on two more or less continuous veins. They are about one thousand feet apart and have a parallel course from southwest to northeast. Beginning at the southwest the eastern range includes an old opening on the Hacklebarney property southeast or east southeast of the old mine, the Skellenger or Samson mine, the Chester hotel property, the Collis shafts and the Swayze mine north of Chester. The western line includes the main Hacklebarney mine, the Gulick mine, Hedges property; Peach-orchard or Creager mine, Hedges mine, Dickerson farm, and the Creamer openings near the Congregational church, west of the village. East of these lines the Budd and Woodhull mines, and the Child's openings may constitute a third range or vein.

Hardin Farm.—One mile south of Chester and west of the Peapack road. Some digging was done here in 1869 by Theo. P. Skellenger, of Chester, and ore in strings and thin veins found, but no further explorations have been made.

Budd and Woodhull Mines.—These are on a line parallel with the Skellenger vein and about half a mile south of the village of Chester. The Budd mine was opened in 1867, and worked a short time by the Chester Iron Company. The Woodhull mine southwest of the Budd, has been pretty thoroughly tested by J. Webb, who worked it for the Musconetcong Iron Works at Stanhope. It is now idle. At one time the vein was eight feet wide, but deeper, the ore seemed to be replaced by what may have been a horse of micaceous gneiss, as the wall rocks continued their regular dip as deep as the workings went. The rock in these was dark colored and very largely made up of hornblende, differing very materially from the rock with the ore. The dip also changed from seventy degrees at the top to about fifty degrees near the bottom. This would indicate a *shoot* structure, the vein being *pinched* up by the *roll* of the walls. The ore is very firm, highly crystalline, and very rich. It was reported as making iron of excellent quality. The prismatic structure of the ore is very marked. Between the main shaft and the Budd openings the attraction and surface diggings show two faults or offsetts, the one towards the southeast, and the second towards the northwest, and each throwing the vein about two hundred feet, so that the working shafts of the mines are on a line.

Proceeding towards the west, the most southern of the first or southeast range is an old mine hole on the Chester Iron Company's Hacklebarney property, about three hundred yards east southeast of the Open Cut Mine. This was going in the old forge times, since which nothing has been done in it.

Topping Farm.—In Chester, this belongs to the Union Iron Company of High Bridge, and both the ranges cross it. The only openings yet made were shallow trial pits on the southeastern range which crosses the property from the adjoining Skellenger shafts in front of the old dwelling. Ore was found in these, but the diggings were not deep enough to determine the extent of the ore outcrops. Southwest of these the compass shows a long and steady line of attraction, running towards the above mentioned old Hacklebarney mine holes.

Skellenger or Samson Mine.—This was opened in 1867, and had been going quite steadily up to the financial panic this year. The mining has been to remove the ore along the whole line rather than to penetrate deeply, and hence none of the shafts exceed one hundred feet in depth. A remarkable feature here, is the comparatively great extent of the changes which the ore has undergone through surface agencies. These are seen in the crumbling, disintegrated rock and rusted and desulphurized ore which are found quite to the lowest levels yet opened. The vein is said to be quite uneven, but to average five feet in width. The surface ore was washed before shipping. The compass shows frequent changes from positive to negative attraction which can be traced towards the northeast, crossing the road on to the Hotel Property. This mine is worked by the Samson Iron Company.

Hotel Property.—Here there are three shafts lately put down by A. N. Elliott, for the Lehigh Valley Iron Company. The vein has been thus opened, but nothing definite was learned of its size or of the character of the ore.

Collis Farm.—This property is held by the Coleraine Iron Company, and is now being tested by them. When visited in December, about seventy tons of wash ore had been sent away and a large pile on the bank had not then been washed. No blue ore had been found, although a shaft down forty-five feet on the dip of the strata had been driven some distance in a hard grey feldspathic gneiss. Between this and the Hotel Property a little ore was got from a pit on this line, on the Creamer farm. All these openings are to be regarded as explorations and not *mines*.

Swayze Mine:—A short distance north of the village, and worked by the Chester Iron Company. The openings extend entirely across this property—a distance of three thousand feet, to General N. A. Cooper's line on the northeast. The first openings were made in 1870, and since that time it has yielded several thousand tons of ore. The attraction can be traced along on the line of the openings and thence on Cooper's lands for a long distance. As thus opened the vein varies from twelve to eighteen feet in width, including in places, a horse of rock three feet across, and dips about forty-five degrees towards the southeast. The rock of the walls is a greyish feldspathic gneiss. For forty feet down, the rock and the ore were much altered, the latter having a rusty appearance and so soft as to be got out without much blasting, thus resemblng the surface ores in all the mines about Chester. The rottenness of the rock necessitated close timbering, making the extraction of the red ore quite costly. Beneath this the rock is firmer and the ore is bluish black, quite hard and contains some sulphur. According to an analysis of average samples sent to our laboratory the chemical composition is as follows:

Silica,	11.50
Magnetic oxide of iron,	81.79
Phosphoric acid,	0.18
Manganese,	trace.
Titanic acid,	0.00
Sulphuric acid,	0.31
Iron disulphide,	3.02
Sulphur,	1.59
Phosphorus,	0.08
Metallic iron,	59.21

The lime and magnesia with the alkalies were not determined. These would probably fill up the deficiency between the total of these constituents given and one hundred.

Some of the sulphur exists in the form of iron sulphate, and is reckoned above as sulphuric acid, but the most of it is in combination with iron alone, as iron disulphide or pyrite or more commonly known as *iron pyrites*. While the sulphur per centage is quite high, that of the phosphorus is low. If this should represent the ore mined here, it might be tried for making Bessemer metal.

On the western range or vein beginning at the southwest end, the *Hacklebarney Mine* is first to be noticed. The earlier work here for the supply of the forges was confined to shallow pits and open cuts, removing the red weathered ore within a few feet of the surface, and leaving the blue ore as undesirable for forge purposes. Since the preparation of the report on this mine in 1868 a vast amount of work has been directed towards the more thorough exploration of the veins on both sides of the Black river. The new shafts and extended open cuts show a wide vein or series of veins half a mile long, verifying the sanguine statements made in that report concerning the probable extent of the ore. On the hill west of the river the openings show at least two distinct veins which are traceable towards the northeast, down the hill, across two off-sets displacing them towards the southeast, to the open cuts on the east side and close to the stream. The amount of displacement is said to be about seventy feet at the river road, although from the line of strike in the open cuts on each side it would appear to be greater, over one hundred feet. The largest amount of work has been in the open cuttings, on the east of the stream. These show three veins, of which the most westerly has been followed about six hundred feet in an open drift running in a little above the level of the river, and removing the ore and its slight covering of earth and boulders to the present heading. The stratification is very distinctly seen, and the dip is towards the southeast, between fifty and sixty degrees. The average breadth of beds removed is about twenty feet; in places this amounted to twenty-five feet. But in this space some layers of rock (horses) were included. A true hanging wall is not reached in this open cut, and but a few feet from this a second vein of lean ore is opened near the river, and a few yards further there is a third. As these last two have but just been uncovered, nothing can be said of their extent towards the northeast. Beyond the main open cut going northeast on the top of the hill, several shafts have struck workable thicknesses of ore, so that altogether there is a great deal of ore *in sight* on this property. Pyrite is very generally distributed through the vein, but in larger proportion in some thin beds, so that by care in mining and a little sorting the amount of sulphur may be reduced much below the average of the whole. In the large open cut both the ore and rock are very hard, and but little weathered quite to the surface. In the southeastern openings there is more rock and a great deal of mica with the ore. The per centage of some of the constituents of this ore, represented as averages from the open cut and the river stopes is here given, viz.:

	Open Cut.	River Stopes.
Insoluble matters,	12.20	23.35
Metallic iron,	59.21	52.03
Sulphur,	5.78	2.33
Phosphorus,	0.08	0.03
Titanium,	0.00	0.00

Gulick Mine.—Ore was discovered on this farm some years ago, but not much was done until 1870 when it was again tested, and in 1872 the Union Iron Company leased it. A shaft sixty feet, with short drifts, has allowed the removal of some red ore which has been sent away. Very little work has been done in the blue ore. The surface ore contains considerable hornblende and mica in laminae alternating with the magnetite. The attraction is strong over a wide belt on the strike of the vein. At the southwest the line approaches the Hacklebarney road, and then crosses it, so running to the Chester Iron Company's property.

Creager or Peach Orchard Mine.—This is about a mile from Chester and a few rods south of the old Washington turnpike. The attraction here for six hundred feet on the course of the vein was positive, with a deflection of the dip needle of from twenty to seventy degrees, and constant over a breadth of seventy-five feet. Several shafts and drifts since made, have proved a workable vein, whose upper portion consists of the red, rusty looking ore so common to all the Chester mines, mixed with some earth and rotten rock, in which there is much mica. This mine has been worked by S. W. George, of Chester, and considerable ore taken out of it.

Hedges Mine:—Three-quarters of a mile southwest of Chester and about one hundred yards northwest of the Hedges' farm house. Here the Union Iron Company, of High Bridge, has done a great deal of work, and in the first year's mining raised about ten thousand tons of ore. The workings consist of a wide open cut descending towards the northeast, which is about three hundred feet long, and at the heading, fifty feet deep. A few yards beyond, in a northeast direction, the vein is further opened by a vertical shaft and a level which has been driven each way out connects with the open cut. The foot wall is a greenish gray feldspathic gneiss, very firm, and dips sixty degrees towards the southeast. It is wonderfully regular in its dip and well defined, so that the ore comes off very readily. The ore as worked measures twenty-five feet to a horse of rock, which is about six feet wide; then there is another vein whose thickness is not yet known. As exposed near the surface it is at least five feet in width. Most of the ore taken from the open cut was got out with a pick and then hoisted by means of two steam derricks on to the bank. Very much of it had lost its sulphur, and was rusty and mixed with rotten rock, requiring washing before being shipped. In the hard blue ore from below there is some pyrite quite uniformly distributed through it. According to analysis of samples collected during the mining, the sulphur amounts to two and forty-six hundredths per cent., the phosphorus to forty-five hundredths per cent., and the metallic iron to fifty-three per cent. The ore is dumped into cars which run from the mine on a short branch railroad to the Chester Railroad extension. It is worked at Harrisburgh, Pennsylvania, into pig for the Pennsylvania Steel Works, where it is used for making Bessemer steel. From the shaft northeast the attraction is quite steady to the *Dickerson Farm*. On this farm there are two shafts out of which ore has been raised. It is lean, the magnetite being mixed with mica and a decomposed hornblende. The line of attraction from these shafts is said to run across the Topping and Hedges farms to the Chester road near the Congregational church. North of this road, and west of the church, this vein is opened on the *Creamer Farm* by the Coleraine Iron Company.

From the character of the ore and the associated rocks and from the observations with the dip compass, these several points opened appear to belong to continuous veins, or if interrupted and broken, to a series of veins parallel to one another and comprised in a quite narrow belt. The compass would fail, unless the observations were much more carefully noted than is customary with practical ore hunters, to show breaks or offsets. Systematic and minute magnetic surveys would do much to settle the question and reconcile the discrepancies existing between the statements of those who are conversant with iron mines in this district.

De Camp Mine, on the farm of David S. De Camp, one mile northeast of Chester and near the road to Dover. This locality was opened in 1869, at three shafts, all within a few rods of the farm house. One of these was reported to be eighty feet deep. The ore seen on the bank is moderately fine crystalline and apparently of good quality, containing but little rock and very little pyrite. Judging from the dump materials, the accompanying rock is a grey hornblendic gneiss. The attraction observed was from fifteen to thirty degrees positive. No ore had been shipped at the time it was visited.

The Leake Mine has not been worked since 1869.

Daniel Horton Mine, in Chester township. about two miles northeast of Chester village, and a few rods southeast of the road leading to Dover. Although first opened in 1867, this mine was not fairly in operation until the following year. After about four thousand tons of ore had been mined it stopped in 1870. One of the slopes is one hundred and sixty feet down, dipping with the vein about fifty degrees towards the southeast. The ore varies in thickness from four to nine feet. A small percentage of rock, mainly quartz, occurs quite uniformly disseminated through the ore matrix. Some of it has been worked in Segur & Lewis' bloomery forge, at Shippenport, and is said to have made a very superior iron. Between the two main slopes the stopes have not been worked out, so that there is a large quantity of ore *in sight*. At the bottom a *roll* of the hanging wall *cuts out* most of the ore. This may not continue very far, and deeper sinking may prove a wider and workable vein. From appearances, this ore is quite free of sulphur and phosphorus. Waterman & Beaver, of Danville, Pennsylvania, are the proprietors. Edmund Canfield directed the mining operations.

Barnes Mine, near the Dover road, three miles northeast of Chester. This was opened in 1869, and worked steadily for three years, under the management of E. Canfield, yielding several thousand tons of ore, which was sent to the Stanhope furnaces. The vein was opened more than five hundred feet in length, and some of the slopes went down about one hundred feet. The dip was sixty degrees towards the southeast, and the average thickness of the ore four feet. Three offsets, about the width of the vein, were found in the progress of the mining. Accompanying the magnetite there is considerable quartz and a little hornblende, making the ore rather lean.

RANDOLPH TOWNSHIP.

David Horton Mine, in Randolph township, about three miles south-southwest from Dover, and a short distance south of the Walnut Grove and Succasunna Plains road, Edmund Canfield, lessee. Here there are three small veins within a few yards and dipping steep towards the southeast. The mining operations are carried on through four shafts, of which the deepest is down one hundred feet. Some of the ore, as seen on the bank, is very rich and fine-grained, but the greater portion of it is mixed with a little rock, occasionally masses of pyrite and small, greenish grains of apatite. The rock coming from the walls is a hard, light gray laminated mixture of brownish mica, glassy quartz and orthoclase.

An average of the ore on the bank, at the time of our visit, was analyzed, with the following result, viz:

Silica,	16.15
Magnetic Oxide of Iron,	68.48
Alumina,	3.34
Lime,	4.87
Magnesia,	1.94
Titanic acid,	1.09
Phosphoric acid,	3.01
Water,	0.40
Total,	99.28
Metallic iron,	49.57
Phosphorus,	1.30

The per centage of phosphorus comes from the apatite granules in the ore, and when it is remembered that some of our best New Jersey ores contain this mineral, this analysis need not appear as disparaging to the character of the mine.

DeHart Mine:—Northeast of the *David Horton Mine* and north of the Walnut Grove and Succasunna Plains road. The report in 1868 speaks of the attraction here as very strong, but the searches had up to that time been unsuccessful. Later explorations have discovered a wide vein, in places fourteen feet, but including thin horses of rock. The dip is almost vertical and towards the southeast. The ore coming from the top of the vein was mixed with some earth. This character continues but a few feet, to the more solid bluish-black ore which contains some quartz, hornblende, and a very little pyrite. The present workings are southwest of the first explorations, and since 1871 E. Canfield has had the mine. The line of attraction is said to be traceable southwesterly across the road to the David Horton Mine, and northeastward across the Lawrence property to the *Carbon Mine.*

Carbon Mine:—About two miles south of Dover, it was formerly known as the *Dalrymple Mine.* In 1868 it was comparatively new in its workings. Since that time the Carbon Iron Company has mined a great deal of ore, opening the whole length of the vein on their property nearly half a mile, from the Lawrence boundary line to the *Trowbridge Mine.* The main workings are at the northeast, near the latter mine lot, and have attained a depth of about two hundred feet, measured on the dip of the vein, which is very steep towards the southeast. Several small faults or offsets have been met with. This vein in its varying thickness is a good example of the lenticular or *bean-shaped* form so characteristic of our iron-ore beds. More extensive opening will probably show a succession of such irregular masses, or *shoots* of ore, so finely exhibited in the Mount Hope, Ringwood, Weldon, Hurd and other old and large mines. In the most northeasterly stopes the vein has measured eighteen feet in width, pinching up in a few yards to a single layer not over as many inches thick. Descending the *pinch* is sometimes due to the change in the dip of the hanging wall, *cutting out* the vein. Another observed feature is the continuation of the dip and of course the walls, while the ore is replaced by rock. This irregularity in the thickness renders it impossible to make an approximation as to the average width of the ore. Very much of the material from the vein is very lean, or more correctly stated is rock having magnetite, or ore as one of its constituents, so that there is a regular gradation from workable ore, lean ore, rock with fifty per centum of ore to that wherein it enters but sparingly. In many cases the magnetite is arranged in parallel laminae or thin layers with the other rock minerals, but more often it is disseminated uniformly throughout the whole mass. No pyrite was seen in any of the ore on the bank at the time of our visit, and it is said that there is no sulphur in it. The rock of the walls is a grey feldspathic gneiss, separated on the foot wall side from the ore by a thin layer or selvage of mica schist. The dip compass shows a positive attraction which is nowhere very strong. At one of the offsets this changes to negative, following the course of the vein. The mine is in low and swampy grounds, and in wet seasons much water has to be raised. The ore is carted to Dover whence it is sent to the company's furnaces at Parryville, Pennsylvania.

Lewis or Herrick Mine.— This opening is on the farm of Aaron Lewis, two miles southwest of Walnut Grove, and near the Mendham township line. There are three shafts east of Lewis' house and Indian brook. One of these was reported to be one hundred feet deep, and the vein in it from four to six feet in width. When visited it had been abandoned, and consequently very little could be learned about it. The ore left lying about the mouth of the deeper shaft was coarse crystalline and mixed with a greenish mineral very much decomposed. No work has been done here since 1870.

Combs Mine.—This is an old mine, reopened in 1864, and stopped again sometime since. The most reliable information was that the quantity of ore was large, but much of it was too lean to mine and cart several miles to the railroad.

Cooper Mine, two miles south of Dover. This locality was worked a little by the Boonton Iron Company. Since 1870 it has been idle.

Solomon Dalrymple Farm, south of Dover and adjoining on the northeast the Trowbridge Mine. A. Beemer, of Dover, has here met with some success in his searches for ore, but nothing further is at present known.

Canfield Mine, a new mine on the Dickerson estate, north of Dickerson Mine. Most of the work has been done during the past three years. At the engine shaft the vein was in places twenty feet wide, but of this from five to ten feet was rock. Southwest of this, and at the border of the meadow, there is an old incline ninety feet long. Here the vein measured seven feet. The ore from the shafts in the meadow has mixed with its magnetite a little quartz and feldspar, but no mica nor pyrite. An analysis reports only traces of phosphorus. The jointed, columnar structure seen in some of the Dickerson Mine ore, is quite a common character of this ore also, and as at other localities where observed, the planes of cleavage traverse the ore at right angles to the plane of the dip, *i. e.*, they run from wall to wall across the vein. In this they resemble the joints in our basaltic trap rocks. About two hundred feet west of this vein another has been opened by a shaft and considerable drifting. This vein dips more gently (about forty degrees) towards the southeast, and measures from four to six feet between its walls. A portion of this breadth is filled with rock, varying the thickness of the ore from one to five feet. The figures given here applied to the workings about a year ago. The mining since may have changed some of them. The Dickerson Mine railroad, passing near the workings, gives a ready means of transportation, and dispenses with the necessity of so frequent handling. This mine is worked for the Dickerson Mining Company by E. Canfield. Over six thousand tons were mined during the year.

Canfield Phosphatic Iron Mine.—This vein of mixed apatite and magnetite is near the road, a few rods northeast of the Ferromonte store. No work has been done since the publication of the annual report for 1871, in which it was described at length.

J. D. King Mine, on the north end of King's hill, southwest of Port Oram. This is supposed to be a continuation of the Johnson hill vein. The ore was of very superior character, but on account of the small size of the vein, its extraction was too expensive for profit. In 1871 the same line was opened further towards the southwest and near the crest of the ridge. Here also the small amount of ore obtained stopped further work.

At the foot of the hill, bordering the Succasunna Plains, and near the Dover and McCainsville road, a vein fifteen feet wide is reported by A. Beemer, of Dover, under whose direction the searches at this point were conducted.

Of the older mines in Randolph township the *Henderson*, *Bryant*, *Connor Foulan*, *Charles King*, *King*, *McFarland*, *Evers*, *Brotherton*, *Erb* and *Scrub Oak* have not been worked to any extent for several years. The uninterrupted work at the *Dickerson*, *Byram*, *Baker*, *Millon*, *Randall Hill*, *Jackson Hill*, and the *Irondale Mines*, has added largely to the dimensions given for some of these mines in their descriptions published in 1868, and proved the continuity of workable veins to depths beyond which the expenses of hoisting and drainage will be too large for profitable mining. The deepest of these mines and the deepest in the State are the Byram, whose slope measures seven hundred and thirty-five feet, and the Dickerson, which is six hundred feet. For the removal of the water from these depths very heavy machinery is indispensable.

The extension of the drifts and the new shafts with their stopes are slowly bringing the mines together, proving the great longitudinal extent of some of these lines. Some of the intervening gaps will, in this way, soon disappear, and we shall see a great vein or sheet of ore, or if not continuous, a belt of veins occurring in a sort of step-like or *en echelon* arrangement upon the upturned edges of which are the several excavations known as mines. So far as penetrated downwards the same general laws of structure and general characters of the ore are found as in the workings nearer the surface. The *pitch* of the *shoots* and the dip are found maintaining remarkably constant angles, and the deviations from the general direction or degree of inclination are short.

ROCKAWAY TOWNSHIP.

Nearly all of the old mines in this township are in operation and much deeper and longer in their workings than in 1868, as then described. Since that date the *Washington Forge Mine* has been deepened over one hundred and fifty feet, and opened over two hundred feet in length. In fact it has been almost entirely developed in this period. The Carbon Iron Company work it.

The *Mount Pleasant Mine* has been steadily worked and very much increased in the length and depth of its workings. The interesting series of *faults* or *offsets* by which the vein here has been broken across, includes several recently discovered and larger displacements, all of which will, by the aid of a mine map and sections, very fully exhibit this structural phenomenon of our iron ore veins.

Baker Mine.—Here, too, the amount of work done has been large, and the bottom in the southeast vein is three hundred and twenty-five feet down, and the extreme length of the stopes here, three hundred and thirty-five feet. The size of the vein, free of rock, the regular dip of the footwall and the great thickness of the earth and rotten rock covering the strata on a part of this property, are very remarkable. This together with the extent of the several workings are to be seen in a mine map from a recent survey accompanying this report. For over two hundred feet down, there was no firm hanging wall and a portion of the ore was left supported at intervals by pillars in place of rock. The Allentown Iron Company, working this mine, are sinking a shaft southwest of this and near the Mount Pleasant turnpike, east of the *Mount Pleasant Mine.* This is on the strike of their southeast vein, and the expectation is to go through the rock on the hanging wall side, several hundred feet, to the vein worked in the Mount Pleasant Mine. A third vein has lately been opened on the Baker Mine property, twenty-five feet west of the main northwest vein. It is small in comparison with the two here worked.

The *Richards, Allen and Teabo Mines* are all yielding large amounts of ore annually, and are important links in this wonderful chain of mines stretching from the Dickerson to Mount Hope. At the *Allen Mine* a tunnel is being driven west from the *Teabo vein* or main vein here worked to strike the big or jugular, Mount Hope vein, which is supposed to cross the property about three hundred feet west of the present line of openings. When last heard from, this distance was almost reached without as yet crossing any workable veins.

Mount Hope Mines.—The very extensive mining operations here conducted and producing annually over one hundred thousand tons of ore, justify more than a passing notice in this description of new mines and workings. The changes since 1868 are so great that a supplementary account is almost an impossibility. The most of the ore mined here, comes from slopes on the jugular, or Taylor, the Teabo and the Brennan veins in Mount Hope, and the jugular vein in Hickory Hill. The big tunnel cutting the veins in Mount Hope about two hundred feet below the summit of this hill, serves for the removal of ore above its level, and also for very much that is mined in the stopes of the Sturgis Mine on the jugular vein, the bottom of which is one hundred and seventy-five feet below the big tunnel level. This vein has been opened underground all the way to Hickory Hill, displaced, however, at the brook at southern base of this hill about one hundred feet towards the east. In Hickory Hill the vein has been worked from two hundred to two hundred and seventy feet in depth for several hundred feet on its course. Such extended openings have brought out, in a most striking manner, the *shoot* structure of magnetic iron ore veins showing the *pinches*, *swells*, *pitch* and *dip*, characterizing them to an extent seen nowhere else in the State. In a full report, these features of this large mine will be noticed at length after more careful examinations shall have furnished the facts for such a description.

East of the Mount Hope veins, two additional veins have been opened in Hickory Hill, but are not now worked.

Johnson Hill Mine.—The Crane Iron Company worked here for several years—up to 1869, since which nothing has been done beyond some surface explorations.

Huff Mine.—This old mine formerly worked at intervals by its owner, Mr. Huff, has during the past three years, been quite actively driven, the ore going to the Port Oram furnace.

Dolan Mine is a short distance north of the Mount Pleasant turnpike and west of the Baker and Richards mines. It was opened in 1869 and worked a short time by the Crane Iron Company. A shaft one hundred and twenty feet deep is said to have passed through three shoots of ore, but they were small and the ore was lean, excepting some got near the surface. On the foot wall the ore limit was clearly defined, but on the hanging wall side, the ore and rock were mixed.

Swedes Mine.—The Boonton Iron Company work this mine. The line so far opened is about thirteen hundred feet long and the bottom drifts two hundred and twenty feet (vertical) deep. The per centage of metallic iron in this ore is reduced considerably by the amount of hornblende quite uniformly distributed through it. But this is compensated by the facilities in mining afforded by the firm walls and the excellent arrangements for removing the ore and water from the mine. The ore is shipped by the Morris canal to Boonton.

Sigler and White Meadow Mines have not been going for several years.

Hibernia Mines.—This long and rich line of ore is furnishing every year a very large aggregate product through the steady operations of the several companies here at work. A careful survey of the whole line has lately been made, and a tunnel is being driven in on the course of the vein from the Hibernia brook valley, at the southwest end of the ridge, which is intended to relieve the shafts on the hill by furnishing a more ready exit for the ore and the mine water. Eventually this tunnel will be continued throughout the several mines to the north end of the hill.

Beachglenn Mines are still worked by the Boonton Iron Company.

Tichenor's Diggings.—On the strike of the Beachglenn vein prolonged towards the northeast, David Tichenor, of Newark, has sunk three shafts and found small quantities of ore. The attraction is said to be continuous from the Beachglenn mines to these shafts, and the rock here resembles that at the mines. The financial crisis temporarily stopped the explorations, so that decisive results are not yet had.

Righter Mine:—West of Meriden and south of the road leading thence to Splitrock. Of the extent of work done here nothing certain is known. A chemical examination of the ore showed it to be of good quality, with a small per centage of titanic acid.

The *Meriden* and the *Splitrock* or *Cobb Mines* are not working.

Splitrock Pond Veins.—On the east shore of this pond a vein has been quite recently opened by W. S. DeCamp, but beyond the removal of the earth and boulders scarcely anything has been done towards further testing its extent.

At the north end of the pond W. DeCamp has re-opened an old mine hole and found a rich coarse-granular ore, resembling some of the Dickerson shot ore. This is supposed to belong to a line west of the main Hibernia Mines while that on the east of the pond is considered as the latter continued. A great deal of careful examination or extensive mining is needed to substantiate these opinions, but as they may be suggestive of fruitful searches they are here stated.

Greenville Mine.—Opened by Pollard & Welsh in 1872, on lands of Hudson Smith, south of the Splitrock and Green Pond road. The vein is said to be about four feet wide. Some ore has been sent away on the Hibernia Mine Railroad.

Southwest of the last mentioned mine the Bethlehem Iron Company did some work in searches for ore, the past season. A long line of attraction is reported.

In this township west of Greenville and near the foot of Copperas mountain, three new mines have been opened during the past three years. Beginning at the southwest the first is on a tract owned by the Chester Iron Company. Richard George, of Dover, has here discovered at several points a quite wide vein of good ore.

Pardee and Canfield's Mine.—Here there are several open cuts longitudinally on the vein, which runs close to the boundary line between the outcrops of gneiss and the conglomerate of the Copperas mountain. These excavations are about fifteen feet in width, but there are some layers of rock in this space. The dip is steep towards the southeast. About two thousand five hundred tons of ore have been mined and sent away. The bottom ore is hard, compact and fine-grained, and contains a notable per centage of pyrite. Near the surface this had been removed by *weathering*. No mining has been done here since it was visited in the fall of 1872. The quantity of ore here is large, and the only drawback is in the cost of transportation.

Green Pond Mine.—This is about a mile northeast of that of Messrs. Pardee & Canfield and near the old Copperas mines. It was opened about a year ago by W. S. DeCamp, since which it has been worked for the Green Pond Iron Mining Company. The principal working is at an open cut or *quarry* at the southern end of a low flat ridge of gneiss. In the heading the ore as exposed is between forty and fifty feet wide, dipping about forty degrees towards the east-southeast. This breadth is measured across a thin horse of rock quite near the foot wall side. The rock on this side of the ore is a rusty-grey fine-grained gneiss containing here and there pyrite. The rock in the *horse* is a micaceous gneiss. In consequence of the thin covering of drift earth, the weathering of the ore has made the upper portion of the beds very friable and almost earthy. At the bottom it is unchanged and very hard. The percentage of sulphur is quite large, owing to the pyrite (or marcasite) occurring in all the layers of the vein. In some of the thinner beds it is much more abundant. A little green hornblende is seen in some specimens. Already three thousand tons of ore have been quarried out and the hanging wall side is not yet fairly uncovered. Fifty yards north of this the vein has been worked to a depth of fifteen feet, but without finding regular walls. The ore closely resembles that at the south opening. Going northward on the strike of the vein shallow test pits have been dug at frequent intervals and ore found in them.

A wagon road along the valley of Timber Brook is being constructed, over which the ore can be carted to the New Jersey Midland Railway, at Charlotteburgh. A branch railroad is in contemplation by the mine owners, and the large body of ore here and at the mines lying southwest of this, would justify its construction. Up to the present time only a few car loads of the ore have been shipped, and this had to be hauled over the steep Copperas mountain to Newfoundland. After roasting, this ought to be a valuable ore, as it contains little foreign matter, except the sulphide of iron.

Charlotteburgh Mines.—The old mines near Charlotteburgh have, since the opening of the New Jersey Midland Railway, been actively worked by the Bethlehem Iron Company. The average shipments for much of the season was one hundred tons a day.

PEQUANNOCK TOWNSHIP.

John Botts' Farm, about two miles north of Powerville and east of the Rockaway Valley. Some work in exploring was done here in the winter of 1872-3, by Charles O. Ripley and William S. De Camp. A shaft was sunk twenty-three feet deep, and about seventy tons of ore taken from the vein, which was between three and four feet wide. The ore resembles that from Mine Ridge, and this is on a northeast and southwest line with the openings on that ridge.

De Camp Mine.—The openings known under this name are on the western slope of Mine Ridge, three miles north of Powerville and east of the Rockaway Valley. The line of attraction and the vein as discovered follow the trend of the ridge for three-quarters of a mile. Some ore was mined here more than fifty years ago for the Powerville forge. The present operations were begun about two years ago, when the whole length now occupied was tested by William S. De Camp. A portion of the property was then leased by the Musconetcong Iron Works. They have five openings in a length of twelve hundred feet, of which the deepest is down eighty-five feet. The dip is about sixty degrees towards the southeast. The rock of the walls is very uniform in character throughout, and is a hard, grey hornblendic gneiss. The ore occurs in a succession of *shoots*, which pitch at about forty-five degrees towards the northeast, are about fifty feet on the outcrop, and average four feet thick. The ore is very hard, quite close-grained, and contains a small amount of pyrite, and in some places a little hornblende also. The hoisting and pumping in the several shafts is done by a single steam engine, from which the power is carried by a wire rope running over friction wheels, and arranged so as to be connected or detached, as needed. This mode of transmitting power is new in New Jersey iron mines. Where the work is at irregular intervals of space and not continuous, it is economical and efficient.

The ore from this mine is sent by the Morris Canal to the Musconetcong Iron Works at Stanhope. The average monthly product during the year up to September was four hundred and fifty tons.

Southwest of the company's lease DeCamp has sunk two shafts on the same vein and mined about five hundred tons of very fine ore. It is peculiarly laminated in its structure by alternations of coarse and fine granular material. At one of these shafts a *cap rock* was found over the ore descending steeply towards the northeast, indicating the same *shoot* structure here as in the company's mine. To the southwest of this lot this same line has been opened on property held by the Musconetcong Iron Works, but the ore found was lean. Several small veins, parallel to this which is worked, are known, but thus far their size and the sulphur in them has prevented their being worked.

Decker Farm.—On the same ridge with the last, just over its crest and east of the mines, a breadth of twelve feet of ore was lately uncovered in a shallow trench and smaller outcrops at other points near this on lands of Mr. Decker. The explorations cannot be regarded as at all conclusive in the results thus far obtained. And here it may be remarked that there is a tendency among those searching for ores to stop with the removal of the overlying earth and to consider the outcrop then visible as representing the size of the vein. In some cases this may be the truth, but more often the breadth at the surface in consequence of *overflows* exceeds that of the more regular and undisturbed vein below.

Gould's Farm, half a mile southwest of Stony Brook. A vein of good ore five feet thick was found on this farm, near the farm house, by Mr. Hussey, of Bloomingdale, using the diamond drill. Three holes were bored, each striking the vein, which dipped steep southeast. The attraction here is said to be very strong and decided on a line one thousand five hundred feet long.

Pike's Peak and Righter Lot, reported in 1868 under the name of *Stony Brook Mine.* This is about three miles southeast of Charlotteburgh and near Earle's Forge, on lands of M. J. Ryerson and Charles Righter. The ore from the openings on Ryerson is apparently of very superior quality. The size of the vein was not learned. On the Righter lot there was said to be thirteen feet of ore and rock between the walls.

PASSAIC COUNTY.

POMPTON TOWNSHIP.

Wynokie Mines.—No work has been done at these mines in several years.

Monks Mine.—This is a new opening on the north side of Wynokie creek, on the property of J. W. Schermerhorn, and about two miles above Boardville. The ore is hard and black, with a little pyrites in it, but almost entirely free from other foreign substance. It has been opened on a vein seven feet wide, but its extent is not tested, and mining has not begun on it.

Board Mine.—This mine was first opened in 1872. It is on the lands of J. W. Schermerhorn, about two miles from Boardville, and perhaps three hundred yards to the right of the road from the latter place to Greenwood Lake. It has been worked along on the vein for a hundred feet or more, and been sunk down perhaps seventy feet. The vein is nine feet thick, and dips southeast thirty degrees. The ore appears to be silicious, and is of a uniform and rather fine grain. A second opening has been made farther northeast on a vein parallel with the first and fifty feet east of it. About nine hundred tons of ore a month have been sent away from this mine during the past year, and it is not driven to its capacity by any means.

Ringwood Mines.—These mines are worked by Cooper and Hewitt for the supply of their furnaces at Ringwood and Durham, Pennsylvania. The amount of work done has, until within a year, been limited by the lack of transportation. This is now removed by the completion of the Midland Railway to Boardville and a branch from that point to the mines. Thus far, however, the product is in nowise proportioned to the capacity of the mines as now opened, much less to that of this property when all its rich veins shall be vigorously worked. The *Cannon*, *Hard*, *Keeler and Cooper Mines* have furnished the ore needed during the past few years. A new opening near the Hard Mine has been named the *Cook Mine.* The attraction is strong and the quantity of ore appears to be large. Since 1868 the *Hard Mine* has been worked down from one hundred and fifty feet, as then reported, to four hundred feet, its present depth. The *Cannon Mine* is not much deeper than in 1868, but is opened so as to show the pitch of the *shoot* between the cap and bottom rocks very beautifully. The ore is remarkable for the smooth, striated plane surfaces which traverse it in all directions. The walls are also wonderfully grooved and polished in lines parallel to the direction of the pitch, which is forty-five degrees northeast. The *Saint George Mine* has been idle for ten years, although the heading of ore is thirty feet across. It is supposed to connect with the Cannon shoots or vein. The *Blue Mine* was worked to a depth of four hundred feet on the slope. It is not now working. The *Keeler*, *Miller and Peters Mines* have also been idle for some years, excepting some mining at the former by M. J. Ryerson for supplying the forge at Bloomingdale. The *Cooper Mine* has a vein twelve feet wide, of bluish ore resembling that of the *Hard*, *Blue* and *Bush* mines, fine-grained, rhomboidal fracture and free from pyrite. The Hewitt vein is opened, but not worked. It shows a width of twelve feet. The ore, like that of the *Snyder*, in the same range, contains some sulphur.

Annexed are tables of analyses of the ores of these mines. The specimens were selected by Philip George, Manager and Mine Superintendent at Ringwood :

ANALYSES.

	Cannon No. 1.	Cannon No. 2.	Cannon No. 3.	Cannon No. 4.	St. George.	Miller.
Sesqui oxide of iron..	65.95	76.08	96.16	90.47	94.66	84.56
Oxide of manganese.	....	....	....	....	.20	.25
Phosphoric acid......	5.56	6.59	trace.	trace.	2.50	4.74
Sulphur.................	....	....	....	....	....	....
Titanic acid............	.80	.70	.70	2.72	.65	.50
Lime......................	6.83	7.77	....	....	2.58	5.04
Magnesia...............	.07	.14	.22	.72	.21	trace.
Alumina	5.09	1.94	1.74	1.91	.39	3.00
Insoluble...............	18 10	7.00	3.10	5.80	2.00	4.60
	102.40	100.22	101.92	101.62	103.19	102.69

The Cannon ores No. 1 and No. 2, are reddish in color, and contain very little magnetic ore, most of it being the red oxide.

	Old Blue.	Hard.	Keeler.	Cooper.	Peters.	Old Hope	N. Hope.
Sesqui oxide of iron..	95.98	90.14	78.30	85.08	91.11	94.06	97.29
Oxide of manganese.	....	.30	.25	.20	.20	.25	.35
Phosphoric acid......	.06	1.86	3.39	5.12	.90	.45	.47
Sulphur................	....	.01	.01	trace.	....	....	trace.
Titanic acid..........	1.95	.40	1.44	trace.	.30	.30	.52
Lime....................	....	2.13	4.03	6.62	1.23	1.57	.62
Magnesia..............	.43	.94	trace.	.28	trace.	.22	trace.
Alumina...............	.66	1.00	1.17	2.80	3.19	2.59	.52
Insoluble.............	4.10	5.60	12.60	3.10	5.40	3.00	2.60
	103.18	102.38	101.19	103.20	102.33	102.44	102.37

	Hewitt.	Snyder.
Sesqui oxide of iron,	69.64	70.68
Oxide of manganese,	.15	.25
Phosphoric acid,	.19	.13
Sulphur,	4.54	.20
Titanic acid,		
Lime,		trace.
Magnesia,	trace.	.47
Alumina,	9.17	.72
Insoluble,	17.30	28.90
	100.99	101.35

The excess above 100. in these analyses is due to the iron being weighed as sesqui oxide, while in the ore it is part protoxide. The phosphoric acid is combined with lime, and not with the oxide of iron.

WEST MILFORD.

Indications of iron ore are numerous in this township, and some ores containing pyrites have been found, but the remoteness from railroad or canal transportation has made iron ore of no value. Now that the Midland Railroad crosses the township and supplies the needed connection with a market, we may expect more activity in the search for ores, and the opening of new mines.

In New York this belt terminates near Monroe and Turner's, Orange county. In that State the numerous mines of the *Sterling Iron Company*, and the *Alice*, *Forshee*, *O'Neill*, *Mount Bashan* and *Clove Mines* are within its limits.

The number of the localities and the extent of the veins as already opened is so much in excess of that of the other belts that it might with justice be named the *iron ore belt.*

MUSCONETCONG BELT.

HUNTERDON COUNTY.

The mines in this belt within the limits of this county reported in the "Geology of New Jersey" were *Bethlehem*, *Van Syckle's*, *Asbury* and *Banghart's*, all on the Musconetcong mountain range. The *Bethlehem* and *Van Syckle's mines*, are the only ones of these which have been worked to any extent since 1868.

The *Bethlehem Mine* has been in operation most of the time. When visited two years ago, the old shafts had been abandoned and the openings then making were further to the east There were two lines of attraction, and shafts were being sunk on both. The strike was east northeast by west southwest. The ore at that time mined was fine-grained, mixed with a little rock, and the wall rocks hornblendic gneiss with some syenite The mine is reported as in operation and the ore is shipped from Valley station, on the Central Railroad of New Jersey.

About half a mile south of the *Bethlehem Mine*, some ore has been found on the farms of J. Van Syckle and George Hubs, on the former five hundred tons were taken out several years ago. The localities have not been visited.

Van Syckle's Mine.—This mine now belongs to Cooper and Hewitt, and the ore is carried to Durham and worked in mixture with silicious ores. This ore is remarkable for the large amount of titanic acid in it.

ANALYSIS.

Magnetic iron ore,	69.34
Oxide of manganese,	0.00
Phosphoric acid,	trace
Sulphur,	1.21
Titanic acid,	11.60

Silicic acid,	5.40
Lime,	.39
Magnesia,	3.35
Alumina,	9.29
	100.58

Miller Farm:—About a mile southwest of Glen Gardner. Here some mining has een done at intervals for several years past, but without finding much ore. The line of attraction is said to be traceable from this farm northeast to the Central Railroad, crossing the "stone cracker quarry" and thence across several farms in Lebanon township. There are supposed to be two veins, about one thousand feet apart. A thin vein of ore occurs at the railroad quarry.

Fritts' Farm, White Hall. A shaft was sunk the past season on George Fritts' farm, northwest of White Hall, and a wide vein of lean granular ore, largely mixed with white quartz, was uncovered.

East of White Hall, one mile, the Union Iron Company, of High Bridge, has a vein of ore opened on the farms of *J. S. Apgar*, *Morris Fritts* and —— *Banghart.*

Banghart's Mine of the "Geology of New Jersey," is on this vein, but it has not been worked since described in that report. This vein is said to be lean wherever it has been opened.

Hunt or Pidcock's Mine:—Near the old Washington turnpike, about two miles east of Pennwell, on Schooley's Mountain. Ore was mined here seventy years ago and used in forges. In 1871 Pidcock and Rothe began work here, sinking a shaft about seventy feet southwest of the old mine hole. When visited about a year ago, they had uncovered a breadth of eight feet of ore. The strata dipped sixty degrees towards the southeast. A very little pyrite was observed in some specimens.

MORRIS COUNTY.

Schooley's Mountain, Pleasant Grove.—During the past three years there has been considerable work done in searching for ore in the vicinity of Pleasant Grove and the Schooley's Mountain boarding houses. But none of these points, excepting the Stoutenburgh Mine, are yet developed into producing mines. West of the Pleasant Grove church a long line of attraction, which in places is very strong, has been tried by several parties who have successively held leases on the property, and some very rich and highly magnetic ore has been found. From information lately received in regard to the openings on the farm of J. P. Sharp, it would appear that the diggings went through the "overflow" and failed because of neglect to follow the ore.

A half mile northeast of Pleasant Grove and near the old Washington turnpike, the Lehigh Valley Iron Company sunk two shafts on lands of Wm. Hann. The attraction was positive and strong, and some lean ore was obtained with rock containing ore as one of its mineral constituents. The same line of attraction was tested about one thousand feet southwest of these shafts by Marsh and Trufant, of Hackettstown. Some ore mixed with rock was found, although the attraction stretches over a wide area about their openings. This may, however, be due to the ore occurring in thin strings and as a constituent mineral in the rocks underlying this area of attraction.

Stoutenburgh Mine.—This is located a half mile northeast of the Schooley's Mountain Seminary, on the farm of L. I. Stoutenburgh. It was opened in October, 1872, and has been worked without interruption to the present time. The mine is now about one hundred feet deep, and opened on the line of the vein about one hundred feet. The vein averages five feet in thickness, widening to nine feet near the main slope. The attraction was quite strong and generally positive for three hundred feet southwest of this slope. The ore was found within two feet of the surface, and for several feet down it was mixed with a little earth, and in loose, irregularly-shaped masses. The dip wa from thirty-five degrees to forty degrees towards the south-southeast. Deeper and west of the main slope it is now reported as steep towards the northwest, whereas east of this the southeast dip is maintained.

The following analysis is of ore about twenty feet down on the slope. At the bottom as now opened it is said to be richer:

Silica,	6.70
Magnetic oxide of iron,	83.04
Alumina,	3.87
Lime,	3.25
Magnesia,	0.86
Titanic acid,	0.70
Sulphur,	0.10
Phosphoric acid,	1.92
Total,	100.44
Iron,	60.130
Sulphur,	0.096
Phosphorus,	0.839

The mine has yielded monthly about four hundred tons of ore which has been used in the furnaces at Stanhope. On the same farm another vein of rich ore, but quite small, has been opened northeast of this mine.

Mr. Stoutenburgh has opened a small vein, north of this mine, on the farm of L. W. Hunt and mined about forty tons of ore free from sulphur.

Naughtright Mine:— A new mine on the eastern side of Schooley's Mountain, and a short distance west of Naughtrightville. It was opened in 1870 and worked about a year, two shafts being put down; the deepest, one hundred and forty feet, measured on the dip of the foot wall. On the north of this slope, a huge trap dike runs obliquely across the line of the vein, entirely *cutting out* the ore in a northeast direction. The rock adjacent to the vein was very much disintegrated and crumbling for forty feet downwards. The ore measured between twenty inches and four feet in thickness, was coarsely crystalline and mixed with a little rock and pyrite.

About one hundred yards west-northwest of this, a shaft thirty feet deep struck a vein eight feet wide, and here, also, the ore towards the north was abruptly replaced by rock. About two hundred tons had been mined when visited. This mine was not in operation the past year. The small size of the vein and the distance to canal or railroad transportation operate against it.

Sharp's Diggings.—On lands of Wm. Sharp, two hundred and fifty yards northwest of the Naughtright Mine, J. M. Sharp, of Budd's Lake, sunk a shaft twenty-five feet deep, in 1870, on a strong, positive attraction, and found some very rich ore with other that was mixed with rock, and quite lean. For two hundred feet southwest from this point, a strong, negative attraction was observed. The rock here is very friable and earthy in consequence of the decomposition of the feldspar, and the dip of the strata is steep towards the southeast. This locality has the same disadvantages as the Naughtright Mine, of distance from transportation.

Rarick Farm:—Adjoins the Sharp place on the north. The slight explorations here indicate a rock containing magnetite rather than a workable vein. It is unlike that at Sharp's in being darker colored and less disintegrated.

Hopler Farm or Bartleyville Mine:—One mile southwest of Bartleyville. From ten to fifty degrees positive attraction was observed over a large portion of the hillside north of the Hopler house. There are some old holes here but no work has been done recently.

Mount Olive.—The mines about Mount Olive have not been in operation for several years past. A. A. Drake has opened two parallel veins on Peter Solomon's farm, and mined ore for the Stanhope furnace, but to what extent has not been learned. At the northeast end of this range of mines several hundred tons of ore have been mined on the *Baptist Church Farm.* This locality is one mile west of Drakesville. From all that can be learned now of the old mines of this Mount Olive range the veins appear to have been continuous but quite small.

The Beattyestown or Fisher, *Dickinson*, *Marsh and Smith Mines* are all on the western side of this mountain range or table land. They have been worked to a considerable extent, but no important developments are reported.

WARREN COUNTY.

SCOTTS MOUNTAIN.

Lanning Farm:—On the summit of the ridge southeast of Oxford Furnace and south of the Washington road. Here are two lines of attraction which intersect going southward from the road. One of them has a course a few degrees east of south, while the other follows the more commonly observed northeast and southwest direction. The point of intersection is near an old mine hole in the field near the woods bounding it on the south. The dip-needle on the western line (north of this hole) varies from forty to ninety degrees, positive; that on the other line (running northeast) varies from twenty to forty-five degrees. The constancy and continuity of these lines is remarkable, and the development of the locality is desired as a test of the value of such magnetic indications. A small vein was uncovered in a shallow trial pit on the eastern line, and ore was found in the older opening near the intersection of these lines. Ore has also been discovered southwest of this in the woods—but the openings are so filled up that the extent of the ore could not be learned.

Chapin and Lommasson Diggings:—South of the Lanning place and in the hillside, west of the Oxford and Washington road. A great deal of tunneling has been done here, following a very small vein of ore into the hill, but without discovering any workable amount. The peculiar features of the place are east and west strike of the rock strata, so finely exposed in the extensive excavations and the very disintegrated, even earthy condition of the gneiss rock, so that nearly, if not all, the work was done without need of blasting. The dip is steep northward. Much of the rock is very brown on its fractured surfaces, and from this prevalent color was supposed to contain manganese to a considerable extent, but an analysis showed only a small fraction of one per cent. of that substance. Higher up the hill, towards the west, there is said to be a fair attraction and favorable indications. The Bethlehem Iron Company has lately leased the property.

Oxford Furnace.—These old and noted mines continue to supply the two furnaces here with rich and first-class ores. The yearly product amounts to about thirty thousand tons, but their capacity is much greater than this. It may not be out of place here to refer to the richness and purity of a sample sent to our laboratory from the *New Mine.*

ANALYSIS.

Sexquioxide of iron,	95.08
Oxide of manganese,	0.30
Phosphoric acid,	0.03
Sulphur,	0.10
Titanic acid,	0.00
Lime,	0.31
Insoluble matter,	7.32
	103.14

Such ore is suitable for the manufacture of Bessemer steel. It is equal to the best of the celebrated Dannemora ore of Sweden.

NORTH OF THE WARREN RAILROAD.

Confucius or Creagor Mine.—This is on the farm of P. Creagor, one mile west of Port Murray. It was opened in 1871 and has been worked quite up to the present time by Charles B. Wight, of Hackettstown. The deepest shaft is down fifty feet, and in this the average width of ore is nine feet. Another shaft twenty-three feet deep, has at that depth struck the solid rock and the vein. A sample from near the surface in the main shaft was analyzed. It is rather lean.

Mitchell Mine:—One mile north of Port Murray. This was opened in 1870. The Musconetcong Iron Company has done a vast amount of work here in mining and searches for additional supplies. A very large open cut removed some hundreds of tons of good ore. A shaft was then put down one hundred feet without much success. Another is now sinking. A mass of granite cut in the open workings and in the shaft appears to have disturbed the strata here so much that the geological relations are not understood. The rock is much disintegrated near the surface. The company is manifesting a great deal of energy in thoroughly testing the property, and their persistence is deserving of better results than so far attained.

Johnson's Explorations.—G. W. and W. H. Johnson, of Hackettstown, are exploring for ore, on a farm a half a mile or less west of the Mitchell Mine. When visited a few months ago, a very little ore had been found.

Egbert Mine:—Two miles from Port Murray, and a quarter of a mile north of the Mount Bethel M. E. Church. It has been worked since 1871 by the lessees, Smith, Gorkey & Sutton. The vein has been opened for considerable length from two slopes, which are one hundred and fifty feet apart, and in the bottom is said to be from six to eight feet in width. Above this there was a pinch and the vein for twenty-five feet down was but a few inches wide. The foot wall is *clean* and well defined, while on the hanging wall side the rock is mixed with ore as far as worked. All the ore contains pyrite, and the per centage of sulphur must be nearly two-hundredths of the whole.

Northeast from this mine the attraction is said to be traceable across three farms—and the line has been tried at several points but without finding ore.

Rockport.—On the same general mountain range near Rockport, a number of trial shafts have been sunk, but none of them have as yet found workable veins. Ore has in every case been seen in the rock strata penetrated, either in thin sheets, in irregular masses in coarsely crystallized granite, or as smaller granular components of gneissoid beds. The attraction leading to searches at these localities may be due to these occurrences of ore or magnetite and not to regular well defined veins. While these shafts are conclusive at certain points, more careful examinations with the needle may justify diggings at neighboring points.

Bald Pate and Searle Mines described in 1868, have been idle since that date.

Buck's Hill, Hackettstown.—During the past autumn the Hackettstown Iron Mining Company sunk a shaft on the Mitchell farm, about thirty feet deep, penetrating a coarse crystalline aggregate of greyish-white orthoclase feldspar, vitreous quartz and magnetite, probably a dike. This may lie between beds of gneiss, but it is more likely to traverse them irregularly and to vary exceedingly in its dimensions, following it downwards.

Frase's Farm:—West of the Hackettstown and Warrenville road, on John Frase's farm, two shafts have been sunk by Bulgin & Cummins, and a lean ore uncovered in one, and a narrow vein in the other.

Young Farm:—Within a few rods of the above mentioned road and on the farm of J. M. Young, a shaft sunk on a line of attraction, penetrated a dark colored gneiss containing in some layers a large percentage of magnetite. On the top of the ridge west of this an ore-bearing rock was again encountered, but this was a light colored feldspathic gneiss.

Pyle's Farm.—The surface explorations here exposed a gneiss dipping steeply towards the southeast, crossed at right angles to its line of strike by an ore-bearing syenite.

Axford Farm.—Here a short line of strong attraction was tested by Perry & Somerville, of Hackettstown. When visited, the ore was in a very narrow vein. The stoppage of the work soon after this was probably due to the limited amount of ore discovered. These ore localities are all west of the road to Warrenville, going from Hackettstown, and within two miles of the former place. East of Warrenville on the brow of a very rocky hill the Hackettstown Mining Company did some work searching for ore. The amount found was inconsiderable.

Bryant Mine:—On the farm of William Bryant one mile southeast of Warrenville and three-quarters of a mile from the Morris Canal. The first openings here were made about seven years ago. The property is now held by the Bethlehem Iron Company but is not worked. When visited, the ore seen on the bank at the easternmost shaft was a mixture of quartz, partially decomposed feldspar and magnetite. That at the western opening was still coarser, crystalline and really a granite with a very large percentage of iron. This is another locality of the so called *ore-bearing rock*. Here, however, there is enough iron in it to allow of its employment as an ore of that metal. As the openings were then full of water the extent of the ore was not seen. But it may be safely said that in such an outcrop there is no certainty beyond what is *in sight*.

Excelsior Mine, on the Stevens' farm near the canal, and three miles north of Hackettstown. This was opened in 1871, and the work of developing it has gone on, up to the present time. Here the ore at the surface is the coarse crystalline mixture of magnetite and the common gneiss and granitic rock minerals, the first so preponderating that it is properly termed an ore. The percentage of iron increases, following this dike downwards. An average sample forty feet from the mouth of the slope gave forty per cent. of iron. The gneiss cut in the excavation is greenish-gray and syenitic. Its dip is steep towards the southeast. When visited a few months since the appearances indicated a change in the course of this dike and a possibility of its assuming the form of a regular vein between regularly stratified rocks. Should this prove to be the case it would be a most interesting locality, proving the association or origin of the ore of these dikes in the stratified ore beds or *veins*. The mining operations have been conducted by Charles B. Wight, of Hackettstown, and his perseverance deserves the success now promised.

Eureka Mine.—This is half a mile north of the Excelsior Mine and in the side hill, not far from the canal. Between these openings there is a wide belt over which the dipping needle shows a very irregular attraction. And this may be explained by the presence almost everywhere of ore in the rock. The geological features and the ore here closely resemble those of the Excelsior Mine. The breadth of ore-bearing rock or lean ore uncovered appears greater than at the latter mine. But little has been done since it was first opened two years ago.

Brookfield or Waterloo Mine.—This mine is worked for the Musconetcong Iron Works at Stanhope. It has been in active operation since 1868, and yielded many thousand tons of very superior ore. The main slope is down about three hundred feet, dipping with the vein thirty-three degrees towards the southeast. A peculiar feature is the north and south course or *strike* of the vein. At the extreme southwest stopes this changes a few degrees towards the west, thus approaching the general trend of our iron ore veins. The ore lies in two sheets or thin veins, separated by a very irregular horse of rock, making the extraction of the ore costly. This is offset by its nearness to the furnace, and also by the quality of the ore.

MORRIS COUNTY.

Jefferson Township.—No new mines have been reported in the portion of this township included in this belt.

The *Hurdtown*, *Weldon*, *Dodge*, *Ford* and *Scofield Mines* have all been actively worked. During the year 1873, the aggregate carried from these mines over the Ogden Mine Railroad, amounted to thirty-eight thousand three hundred and thirty tons. The deepest of these is the Hurd Mine, whose main slope is about eight hundred feet in length—the longest in the State. In consequence of its rather gentle inclination—being that of the pitch of the shoot, twenty-two degrees; its vertical depth is not equal to that of the Dickerson or Byram Mine. This shoot maintains its size, and the cap and bottom rocks together with the side walls enclose it on all sides. The ore continues rich and free from pyrite. It is used by the Glendon Iron Company in their furnaces at Glendon, Pennsylvania.

The *Weldon Mine* is interesting on account of the two shoots of ore which pitch side by side towards the northeast at about thirty-five degrees, slightly approaching one another as they descend, so that at the bottom now reached they are only seven feet apart. A survey of this mine was made in the summer of 1872, and the sections then constructed show plainly this unusual structure.

Lower Weldon.—South of the Weldon and on the same vein is the *Lower Weldon Mine*, worked by the Weldon Iron Company. Beyond this towards the southwest there have been some searches made on the Johnson property, but these were not very successful.

The *Ford Mine* is worked for the Musconetcong Iron Works and is opened three hundred feet in length, and yielded during the past year about twenty thousand tons of ore. It is remarkable for the width of the vein and its almost vertical walls; in this latter feature resembling the Hurd Mine.

The *Davenport*, *Boss*, *Fraser*, *Goble and Duffee* and *Shongum Mines* also in this township, are not in operation.

SUSSEX COUNTY.

BYRAM AND SPARTA TOWNSHIPS.

Smith or Cascade Mine.—This is an old mine worked fifty years ago for the Andover Forge, re-opened in 1869, since which date it has been quite steadily worked. It is about one hundred feet deep, and opened two hundred and thirty feet in length, having a breadth of ore varying from three to eleven feet. The foot wall is a hard hornblendic gneiss, while the hanging wall rock is more micaceous. An irregular horse of rock separates the two portions of ore which are worked. Pyrite is quite abundant in both the ore and rock, although it is said to decrease in amount going down. The dip is fifty degrees towards the southeast, while the strike is northeast by southwest. About sixty yards north of these openings is the outcropping "steel vein," a thin vein of very rich and highly magnetic ore; but this is so small and irregular, appearing more like a true vein, that it has not afforded any considerable amount of ore.

On an adjoining property belonging to Elisha Allis, north of the Smith Mine, ore has been discovered and some mining done.

French's Mines.—West and northwest of Waterloo, there has been considerable searching upon the lands of Jas. French, and some of the ore mined on his property was seen last summer on the canal bank near Byram. This was a very coarse crystallized mixture of magnetite and feldspar, similar to the ore from some of the *dike* localities above mentioned. The mines were not visited. The amount mined was reported as less than a thousand tons.

Hude or Stanhope Mine.—This old mine was re-opened in April and worked until September last by E. Canfield. The veins appeared irregular and quite flat, and the ore was taken out from open workings. About three thousand tons were mined and sent to the furnaces at Stanhope and Port Oram.

The old *Silver* and *Haggerty Mines*, also near Stanhope, have not been in operation in several years.

Sickles' Mine, on the farm of W. Sickles, two and a half miles south of Sparta. It was worked a short time in 1870 and 1871 by the Bethlehem Iron Company. A whim shaft thirty feet deep was sunk near the farm house, and from this short drifts were driven. These yielded about four hundred tons of ore. The rocks as seen on the dump were a light greyish gneiss traversed by seams of epidote. The ore was said to have been twelve feet wide at the top, but only five feet at the bottom. In a second shaft on the line of strike, and one hundred and fifty yards from the first, the vein was between two and three feet wide and the ore was very rich. The wall rock at this point contained some ore in layers or sheets, separated by thin partings of rock. A noticeable feature here is the change in the direction of the dip from east-northeast at the west side of the shaft to east on the south side. Northeast of this near the brow of the hill, the attraction, strong and positive, was observed over a quite long and broad belt. A shallow trench on it exposed a little good ore. On this line continued on McMickle's farm, a single trial pit showed some ore, but beyond the fact of its discovery, nothing further was learned. The magnetic indications are sufficient to stimulate to further trials.

Gafney Farm.—Three miles north of Roseville, Byram township, Sussex county, now belonging to the Rutherfurd estate. These are old openings on this property—they are now partially filled up, but ore of good quality is scattered about them. There is a strong attraction in a line through them which was followed for eight hundred feet, and was found to be continuous, though there were several changes from positive to negative, indicating that the ore is in shoots or else is broken up by offsetts. The range is a little east of north, and further on in that direction, in a wood lot, the attraction is so strong and decided that we have mapped the notes of its survey and present them with the map under the head of searching for ore.

Southwest of the Gafney farm, the range and attraction continue to the *Lawrence farm*, where there are also some old mining works. This long and well marked line of attraction is worthy of further examination.

East and southeast of Sparta, and south of Norman's Pond, indications of ore are found, and some pits are reported to have been dug and ore uncovered, but no mining has yet begun.

Ogden Mines.—These old, well known and productive mines are still vigorously worked. The Allentown Rolling Mill Company, the Lehigh Valley Iron Company, and the Musconetcong Iron Works occupy the mines. Twenty-seven thousand seven hundred and twenty tons of ore have been sent out on the Ogden Mine Railroad in 1873.

In Hardyston Township, southwest of Snufftown, there is a long line of attraction from the Midland Railway, on lands of George Greer and the Franklin Iron Company, southwestward almost to the Ogden mines. The attraction is variable in strength and changes many times from positive to negative, but is continuous. Pits have been sunk on the line in a number of places, and some lean ore has been found, not enough as yet to warrant mining. It would however, warrant a much more thorough exploration by digging.

The Hopewell Forge line of attraction has been worked upon in many places, but we have no information of its present condition and prospects.

WEST MILFORD TOWNSHIP, PASSAIC COUNTY.

Kimble Farm.—A mile northwest of Stockholm. Three shafts or trial pits have been sunk on the ridge northeast of the farm house. One of these was thirty-five feet deep—twenty feet being in earth and boulders and ten feet in a lean ore. The work was discontinued.

The Budd and Hunt Tract, near the head of the Dunker Pond brook. Diggings for ore were made here many years ago. In 1872 the search was resumed and ore containing pyrites was found. There is a strong attraction to be observed there, but no mining has been done.

West of the tract just named, on lands belonging to S. T. Scranton and the Rutherfurd estate, there is a line of remarkably strong and constant attraction. Trial pits have been sunk in several places, and ore was found in all of them, quite near the surface. No mining has yet been begun.

On the hill northwest of the last named lot, two long lines of attraction have been tried at three points, and a pyritous ore uncovered. The openings were very shallow, and no further work has been done. A map of these lines of attraction is given to illustrate the article on searching for ore.

The Jennings and Rutherfurd Line is a line of attraction that runs on a northeast and southwest course obliquely across the county line, and is said to be traceable quite up to the Wawayanda Mine. The Carbon Iron Company own the mines on the Jennings property, and have tested by shallow pits, the condition of the vein at many places, the one three hundred yards north of the Jennings house, being the most southerly. The average thickness of the vein uncovered is eight feet, and it dips steeply to the east-southeast. The ore is rather lean and contains some pyrites. On the Rutherfurd property the same line was tested by E. H. Wright, in 1870. A vein twenty-four feet wide was uncovered in a trench dug across the line of attraction. The ore appeared to be of good quality. The needle was singularly affected in crossing it, being negative at the edges and strongly positive at two intermediate points. At one of these points the ore was changed from massive to a shot-like structure. Nothing was seen to explain this unusual action, and another cross trench gave negative attraction throughout. No further work has been done to prove the vein.

Canistear Mine.—On lands of the Franklin Iron Company. The magnetic surveys of this property indicate at least three veins. The attraction was strong and positive on the most westerly line. The explorations made at the time of our visit two years since, showed a wide vein of rather lean ore, dipping steeply to the southeast. Ore had been raised from each of the other veins, and large piles of rather lean and pyritous ore were seen. Considerable mining has been done at this place, as we are informed, since the time we examined it.

Tracey and Crane Farms, north of Stockholm, in Hardyston, have ore upon them. It is rich and contains very little sulphur. The mine is only a half mile from the railway station. Some ore has been sent away. It was mined by George Richards.

Henderson Farm joins the last mentioned property on the north. The line of attraction here is strong and continues for a long distance. Ore was uncovered in a single opening eighteen feet wide. The line is thought to be west of that on the Tracy property.

Williams' Mine.—This mine is on lands of J. I. Williams' heirs, a half mile east of the Vernon and Snufftown road, and in Vernon township. It is an old mine, and has been worked at times for the last sixty years. It has been actively worked during the past year by Potts & Linn, of Jersey City. Three shafts are down. The southwest shaft is the deepest, and shows a steep dip to the northwest. The next is one thousand feet farther northeast, and the ore in it dips steeply to the southeast. The third shaft is two hundred feet farther northeast, and has the same dip with the last. The vein is irregular in breadth—the ore is quite free from rock and from sulphur. The mining operations are quite extensive and a large amount of ore has been taken out. It formerly went to Wawayanda Furnace, but now it is carted to Stockholm.

Segur & Wright Lease.—On the Rutherfurd estate, adjoining the Williams Mine on the northeast, and probably in continuance of that vein, ore has been found but no mining has yet been done.

Still further to the northeast ground has been opened on two different lines of attraction, on the farm of Jacob Hunt. Ore was found upon both lines, but it was not further proved by mining. The northwestern line may correspond with a line across the Williams property, about a thousand feet west of that on which the mine is worked.

East of Vernon, on the Wawayanda Mountain, searches for ore have been made on lands of Azariah Parker, but the results are not reported.

Wawayanda and Green Mines, have not been worked since 1868.

Ten Eyck's Diggings, near Greenwood, West Milford township, Passaic county. Here there is a long line of strong attraction, opened at five points and a lean ore uncovered, beyond which no further work attesting the extent of the ore has been done. The strata are nearly vertical, dipping southeast. Nearer the Warwick road and east of these openings the dip is toward the northwest.

This belt extends into Pennsylvania, and all the mines of the South Mountain range, between the Delaware and the Schuylkill are in it. It also extends into New York, and the Warwick and Bull Mines are in it.

In the Musconetcong Belt, at several of the localities described, reference has been made to *ore-bearing rocks* and dikes containing magnetite, either in addition to the ordinarily occurring minerals of granites and syenites, or as replacing one of these. Such rock affects the dipping needle as strongly as a regular vein, but careful magnetic surveys show generally a distinction, as the deflection over such rock outcrops is more unsteady and varying from negative to positive in character, or vice versa. And also such outcrops show broader and more irregular areas of attraction and not *lines* or belts corresponding with the strike of the rocks, as is indicated by viens. From the indications given by the needle over these rocks many persons have worked in them hoping to find regular veins. More than a dozen such localities have been visited during the past season, and others in previous years. They have been studied closely, and with two exceptions they have all failed to repay the explorer for his time and the money spent in testing their value. Adverse opinions have always been given to prospectors working in such rocks, based on the nature of dikes in general, and upon the numerous failures in the range of our observations. In the pursuit of field examination of rocks a number of additional outcrops of such ore-bearing rocks have been seen, some of them occupying extensive areas. In the two exceptions alluded to the percentage of iron was sufficient to make the whole workable as an ore. Sometimes there is a marked increase in the percentage of iron in descending, as at the Excelsior Mine near Hackettstown. And it is possible that these dikes may sometimes be followed to regular veins, showing them to have in some way derived their magnetic iron ore from the regular ore-beds or veins. But in general it may be safely asserted that from the known irregular and uncertain extent and direction of dikes, a fact well established in geology and from the experience of miners who have worked in such outcrops, that the explorations in them should be conducted with the utmost prudence and always considered as extremely hazardous.

PEQUEST BELT.

WARREN COUNTY.

Marble Mountain Mine.—This is properly in this belt although the ore is a red oxide. Considerable interest attaches to this locality, as the ore lies in a talcoid rock formation occurring in the gneiss, or resting upon it, unconformably. Practically, the mine has little value, as the amount of ore appears very limited. It is included under this general head, exceptionally, since it is not magnetic, but because this variety of ore and its accompanying slaty rocks are found in this belt only, and it may therefore be considered as one of its characters. It has not been worked for more than a dozen years past.

Schuler Openings.—These are on the farm of William Schuler half a mile north of Roxburg, Oxford township, Warren county. There are two shafts here, one of which is merely an old mine hole deepened. This was dug about one hundred years ago. As re-opened it is twenty-seven feet deep. The other, fifty feet west of this, is fifteen feet deep. Both are in a greyish white crystalline limestone, dipping steep towards the southeast. The vein as worked in the westernmost shaft was two feet wide and much broken up, so that it was got out with pick and shovel. In the old shaft the stratification and the size of the vein were not made out with certainty. The ore is brownish-black, fine-grained and highly magnetic, and contains considerable manganese. At the time it was visited only a few tons of ore had been mined and this was then on the bank. Samuel Vannatta and Alexander Sherrerd are the lessees. It was re-opened the past season.

Roseberry Mine.—This mine is on the farm of Depuy Roseberry one mile southeast of Belvidere. Three shafts have been put down. The work began in 1872, and mining was discontinued after about a year's operation, owing to the vein pinching to a thickness of six inches and failure to find another shoot. About one thousand tons of ore were shipped to the furnaces of Messrs. Cooper & Hewitt, at Durham, Pennsylvania. The ore is mixed with considerable mica and a bluish shaly rock and consequently is lean. It was liked at the furnaces to flux with other ores.

Barton Mine.—This is on lands of Mrs. Barton, half a mile south of Oxford. The principal shaft is on the eastern slope of the ridge and about five hundred yards east of the Oxford and Montana road. About two hundred feet west-southwest of this and on the summit of the ridge there is a trial pit on the same vein as indicated by a continuous line of attraction (of ten to twenty degrees positive) connecting these two openings. The ore seen at the mine was reddish-black granular mass, with a little hornblende in it. A dark colored micaceous gneiss abounded in the ore dump. At the trial pit or trench the stratification is very distinct, standing on edge, with a strike north eighty degrees east. The mine was not working when visited.

Shoemaker's Diggings.—Northeast of Oxford three-quarters of a mile, on top of the ridge east of George Shoemaker's residence a shaft was sunk in the past autumn in search of ore, which resulted in discovering a wide belt or vein of rock containing magnetic ore arranged in parallel lines with the usual gneissic minerals. The hope was entertained that the magnetite would gradually increase until the beds should be rich enough to work as ore. At the time of our visit this locality was not promising, and the experiment appeared likely to be costly and fruitless.

Redell Mine.—At the foot of the hill about three hundred yards east of the Shoemaker locality, the North Penn Iron Company worked here in 1872, and mined an ore which was considered of very superior quality. It is brownish black, manganiferous, free from sulphur and contains traces only of phosphorus. There were two shafts from which there was some drifting. At the lower one, at the border of the meadow, report says the rock next the ore was a greyish crystalline limestone. As this rock is seen but a few rods southeast of this point, it is highly probable that the report was correct. The reason for the stoppage of work was not learned.

Little Mine.—This also is a new mine and is on the farm of Jephtha Little, one mile west of Oxford Furnace. The outlay here in mining, is said to have been very considerable, and the amount of ore raised not at all commensurate with this large expenditure. Much of this was required by the large body of water to be raised. As no opportunity was had of going through the mine, it being stopped before it could be examined thoroughly, the extent of the vein is not known. The lines of attraction indicate two parallel veins, about one hundred and sixty feet apart. The main shaft on the westernmost was said to be seventy feet deep, connected by a drift with a second towards the northeast. The ore near the surface was black, granular and mixed with a brownish-black earth. This was washed. Below this, it was very compact, hard and almost entirely free from all foreign matters. The purity and quality are best shown by the following analysis, of the best ore of the mine:

Insoluble matter,	1.60
Magnetic oxide of iron,	94.76
Phosphoric acid,	0.10
Magnesia,	0.29
Oxide of manganese,	1.00
Sulphur,	0.10

The soft surface ore contained more manganese than the above sample afforded. The purity of this ore and the favor it received from Oxford Furnace, should prompt to a thorough but judicious search to test the extent of the workable vein. It was worked by a Belvidere company.

Raub Farm.—On the farm of Philip Raub, about one mile northwest of Oxford Furnace, several test pits in examination of this property, have been dug under the direction of the lessees, the Bethlehem Iron Company. One of these, about two hundred yards north-northeast of the farm house, was sunk sixty-eight feet before reaching any very solid rock. It passed through several feet of brown-black earthy, manganiferous iron ore which, as cut in this pit, seems to dip gently towards the northwest. It appears likely that further digging, by following this earthy bed, will find below a regular vein of which this is the *overflow*—*i. e.*, the vein spread out or fallen over from its original highly-inclined or vertical position. It now lies as opened, between earthy beds mainly made up of disintegrated gneissic rock. This soft earthy ore was found to contain of

Iron,	49.34	per cent.
Oxide of manganese,	7.50	"
Phosphoric acid,	0.25	"
Water and organic matter,	13.55	"

Southwest of Raub's house and across the Oxford road, a shallow pit uncovered a bed of earthy ore very similar to that described above, and in the bottom exposed a magnetic ore associated with an impure limestone. This opening appears to be on a line connecting the deeper shaft and the Little Mine shafts. The ores are alike at the three points The attraction at these openings is very slight and irregular. The discoveries already made should lead to further exploration in order to thoroughly learn the value of these deposits. From their proximity to the crystalline limestone outcrops, it is very probable that this vein is in that rock. And, if so, the character of the ore is almost assured in advance.

Titman Shaft.—This is in the road near Titman's house, southeast of Bridgeville, and on the southside of the creek. The rock in which it was sunk is a greyish to red slate, bordered on the south by micaceous and hornblendic gneiss, and on the north by the ordinary blue magnesian limestone, and probably unconformable to both of them. The ore found here so far has been very little. It resembles the red hematite of Marble Mountain and this is another of such localities, characterizing this belt. It is intended to resume work early in the spring.

Pequest Mine.—Oxford township, Warren county, two miles northeast of Oxford Furnace. This name is properly limited to the large open working or *quarry*, at the side of the Pequest creek, although it sometimes includes the tunnels in the side hill north of this on the same property. Ore was discovered here about four years ago, and from that time onward, it was worked almost uninterruptedly for three years. A large amount of material was taken out including several thousand tons of lean ore, making a very large excavation in the hill-side. The geological features were for a long time not understood and even the stratification was uncertain, and it was regarded as a huge *pocket* of ore, and not a vein having walls and a dip and strike. The removal of so large a mass shows the foot wall dipping about seventy degrees towards the east and southeast. On the hanging wall side, the rock is more mixed with ore, although here also the dip of the strata is now plain. Towards the southwest the mining appears to have removed all the ore, leaving micaceous and hornblendic gneiss as a sort of bottom rock, underlying this great swollen shoot of ore. A shaft sunk thirty feet beneath the floor of the open cut penetrated rock containing some ore, but not rich enough to work. On the north, the ore was bounded by a wall of grey syenitic rock which ran east and west and dipped steep towards the north. In the language of the miners it was "cut out" by this "cross-course," or dike of geologists. Beyond this the vein has not been discovered, and it has probably been displaced towards the west, or up the hill, judging from the direction of this dike. A tunnel was driven into the hill some rods southwest of this to intercept the vein continued in that direction but no ore was found. Very recently another was started near the store, running in from near the creek level to cut any vein below the *quarry* or mine level. But this was stopped by the water coming into it from the mine. So large a body of ore so near the surface was easily taken out, after the overlying earth and boulders had been removed. A short tunnel for a track crossed the interval of rock between the ore and the road, below which level but little was found. Another advantage in *mining* here, if such it could be called, was the soft and disintegrated nature of both ore and accompanying rock so that very little blasting was necessary. Hence a very large amount of comparatively lean ore was taken out, and sold at a profit at *low* prices. A large percentage of it consisted of greenish hornblende, partially decomposed. The locality is characterized by the abundance of this mineral, as can be seen in the dark-colored hornblendic gneiss forming the foot wall of the mine. Some of this rotten greenish mineral was analyzed and its composition is here given.

Silica,	49.050
Protoxide of iron,	14.952
Alumina,	4.987
Lime,	17.584
Magnesia,	9.648
Phosphoric acid,	trace.
Water,	3.300
	99.521

The magnetic portion of the ore consisted of

Insoluble matter,	18.300
Magnetic oxide of iron,	67.471
Alumina,	3.226
Lime,	5.936
Magnesia,	3.276
Oxide of manganese,	0.250
Water,	1.950
Phosphoric acid,	trace.
	100.409
Iron,	48.84

Some of this ore was tried in one of the furnaces of the Crane Iron Company, at Catasauqua, Pennsylvania, making an open grey pig iron, which went to the National Iron Company's works, at Danville, Pennsylvania, and was worked into steel, which was said to be of superior quality. About three and a half tons of ore were needed for a ton of iron, showing it to be quite lean. In consequence of the ore *running out*, or, in other words, the gradual replacement of the magnetite of the strata by the more common rock minerals, the mine has been abandoned.

Henry Tunnel.—About three hundred yards north-northeast of the Pequest Mine, and on the same property, but one hundred and fifty feet above the creek, an old tunnel has recently been re-opened and extended into the hill until it has attained a length of six hundred and fifty feet on a nearly north course, and following most of this distance, the foot wall of a vein which is, on an average, fifteen feet wide, and dips steep towards the east. Lower down the hill, a second tunnel strikes the same vein about fifty feet below the Henry tunnel. This is now connected, by a shaft at its farther end, with the upper tunnel. A third drift, starting near the foot of the hill, runs across the strata and strikes the vein about one hundred feet below the upper one, thereby affording easy and ready means of working and draining this new mine. The strike and dip of the vein at the several points, in addition to the uniform character of the ore, prove these different levels to be in the same continuous vein, and show its great extent and remarkable uniformity of character. The walls everywhere are unusually regular and well defined. The ore from near the surface of the hill, has a very striking banded or laminated structure from the alternations of magnetite and rock (mostly a micaceous gneiss). This ore is quite lean. An analysis shows its composition to be as follows:

Insoluble matter,	54.400
Magnetic oxide of iron,	37.265
Alumina	4.764
Lime,	trace.
Magnesia,	1.611
Oxide of manganese,	0.400
Phosphoric acid,	0.096
Water,	1.200
	99.736
Quartz or silica,	49.400
Iron,	26.984

Deeper in the hill these partings of rock grow thinner or disappear in part, and the ore is richer and does not exhibit the banded appearance of the upper portions. It should be stated that this parallelism of mineral arrangement conforms to the stratification.

This gradual increase in the richness of the ore going down in the vein is interesting, and in this case of vital importance, as the top ore is hardly workable. The regularity and size of the vein, and the ease of approach to it, may enable this company to use all the ore mined.

North of the upper tunnel this same lean ore has been uncovered in a succession of trenches dug across the line of the vein, extending quite to what is known as the *Hoit Farm Mine*. The attraction is noticeable as covering a great portion of the hill near its summit, and connecting the Henry tunnel with the Hoit farm mine, one thousand five hundred feet apart. This connection is not, however, yet demonstrated by openings.

Hoit Farm Mine.—This is also a new mine, and with the Pequest Mine, belongs to the Pequest Mining Company. It is about half a mile northeast of the company's new furnace and on the western slope of the ridge, but a few rods from its crest. The slope is now one hundred feet long, measured on the dip of the vein which is about thirty degrees towards the southeast, growing steeper going down. From this a drift has been cut about seventy feet into the vein going southwest. As now opened this drift presents the curious phenomenon of an arched roof with sides of ore, the vein dipping from it towards the southeast at the angle of the slope, and in the opposite direction more gently. There may be an anticlinal axis here, or an overthrow of the vein westward or down the hill. The slope has proved its course towards the southeast. Of the probable extent of the western dip nothing additional can be said. The walls of the mine are regular and the ore comes off *clean* from them. Stratification is shown finely in the vein itself. The ore is not so fine grained as that of the tunnels above mentioned, nor does it have the same parallelism in its structure. It is very hard and contains much brown garnet in irregular masses, also considerable augite and less quartz, and other more common minerals of the gneiss. The composition of an average of the mine is as follows:

Silica,	18.90
Protoxide of iron,	27.23
Peroxide of iron,	38.29
Alumina,	12.48
Lime,	4.45
Magnesia,	0.86
Phosphoric acid,	0.06
Oxide of manganese,	0.55
Titanic acid,	1.30
Sulphur,	1.23
Total,	100.25
Iron,	61.69

It has not yet been tried to any great extent, most of the ore mined being on the dump. From its composition there appears to be no considerable percentage of constituents which might work injuriously.

About a quarter of a mile north of the Hoit farm house, a shaft sunk on a strong attraction struck a fine-grained aggregate of magnetite and hornblende crystals, too lean, however, to be called an ore. It has been said that this was the Pequest Mine line, *thrown* one thousand feet towards the west, but a difference in the structure and character of the *ores* is against the hypothesis.

Northeast of the Hoit Farm mine there is a strong attraction traceable for a long distance, and there are some old mine holes at which a striped, or banded ore, like that at the Henry tunnel, was found.

Smith's Mine.—A new opening made during the past summer and autumn on the farm of Philip Smith, a few rods south-east of his residence, and not quite a mile northeast from Green's Pond. When visited, a few weeks ago, two trial shafts not over twenty feet in depth had been started, and a long ditch was then being dug to drain these of the large amount of water flowing into them. The covering of drift earth was about six feet thick. Under this the shafts went through several feet of brownish-black earthy ore, which contained forty-five per cent. of iron and 6.5 per cent. of oxide of manganese. This resembles in appearance and composition the soft ore, at Raub's place and at the Little Mine, also in this belt. Some calcite and some very fine white mica was noticed, also asbestos among the rock constituents of the strata cut in the shafts and ditch. The hard black ore resembles that of the Deats Farm, a mile northeast of this point. No ore had been taken out excepting that coming from the shafts. Edward Turner and Geo. E. Swayze, of Hope, are working the locality.

Deats Farm.—This also is a newly opened ore-locality, and is scant a mile from Smith's Mine. It is about one thousand feet south thirty degrees east from Deat's house, and on the Bartow Hill range. It was opened the past summer and the explorations were continued quite to the beginning of the winter. A Belvidere company did the work. The vein found in the deepest shaft (which, when visited was twenty-two feet deep,) consists of an irregular mixture of hornblende and magnetite, very compact and hard. A little calcite was noticed in the syenitic gneiss of the hanging wall. Also, a few small crystalline nodules of pyrite. The attraction here was light, nowhere more than ten degrees positive, and quite irregular. Two hundred feet west of this a trench opened a coarse-grey syenite in which there was some magnetite. The locality cannot as yet be considered as a mine.

Kishpaugh Mine.—This large and noted mine is two and a half miles west of Danville, and about a quarter of a mile south of the Hope and Danville road. It was opened in the summer of 1871 by Edward Bulgin, and has been vigorously worked by the Crane Iron Company, proprietors of the Kishpaugh Farm. The main slope is two hundred and thirty-five feet long, descending at thirty-eight degrees at the start, and more steeply near the bottom. The main heading on the bottom drift, southwest, is about one hundred feet from this slope. Here the vein, as worked, is twelve feet wide, but some ore is left on the hanging wall side, as the ground above is not very safe. In places it has been twenty feet wide. The foot wall consists of a rotten feldspathic gneiss, mostly made up of feldspar and quartz. Northeast of the slope now worked the *overflow* was fifty feet wide, and the surface diggings removed almost an acre of ground. A few rods beyond the open workings there is another slope in which very little ore was obtained. A sloping drift towards the southwest struck the vein where it was quite as wide as in the extreme southwest stopes. These two slopes are thus connected. On the strike northeast of this last slope a small trial pit showed only a foot of ore beyond which point the vein has not been tested. Southwest of the hoisting slope now working there are several pits, and in all, the ore was uncovered, although in consequence of the very great overflow and the disturbed state of the vein and rocks everywhere near the surface, the size of the vein is not certainly settled. As thus tested the vein is about seven hundred feet long. But the attraction shows that it is continued southwest beyond the property line on to the Cook Farm. The amount of attraction is small, generally under ten degrees, positive. At a few points, where first opened it is strong, and both positive and negative are observed within short distances. A remarkable feature is the extent to which the rock has disintegrated, becoming a loose mass of stone and earth, so that for seventy-five feet down the main slope was in what might be termed an overflow. And at the bottom, at least one hundred feet, vertically, from the surface, the rock is very fragile and the ore is removed with the aid of only an occasional blast. This rottenness of ore and rock makes timbering expensive and the mine to some degree insecure. The ore contains considerable rock, mostly mica and a green hornblende, in thin layers and irregular sheets in the vein stratification. Some of the richer portions are entirely free of rock and show very often a jointed or prismatic structure, the divisional planes of which run at right angles to the plane of the dip. On the foot wall side a thin layer of the vein holds some pyrite. A carefully selected sample, considered to be an average of the mine, was obtained from the dump at the Crane Iron Company's furnaces, Catasauqua, Pennsylvania, and analyzed. The analysis is here given, viz.:

Silica,	21.80
Protoxide of iron,	17.97
Peroxide of iron,	40.32
Alumina,	9.00
Lime,	4.37
Magnesia,	4.03
Oxide of manganese,	0.50
Phosphoric acid,	0.32
Sulphur,	0.05
Water,	1.64
Total,	100.00
Metallic iron,	54.25
Phosphorus,	0.128

The ore is smelted without admixture of other ores, and requires only about half the amount of limestone that is used in their other furnaces working other ores. The ore is almost earthy in consequence of its extreme disintegration, so that the blast penetrates the compact mass with difficulty. Also takes more coal per same burden as their other ores. The pig from it is sold to the Pennsylvania Steel Company at Harrisburgh, for manufacture into Bessemer steel, of which it is said to make an excellent quality. The ore is carted to a switch on the Delaware Lackawanna and Western Railroad, near the new Pequest furnace and is thence shipped to Catasauqua. The annual product is approximately estimated at eighteen thousand tons.

MINES ALONG THE EAST SIDE OF JENNY JUMP MOUNTAINS.

Welch and Inschow lots.—These occupy a low limestone and gneiss ridge west of the Great Meadows, about a mile north of the Hope and Danville road. Two trial pits were dug here by Chas. Scranton a little more than a year ago, and in these a lean ore was found imbedded in a greyish-white crystalline limestone, whose dip was steep towards the northwest. The rock is quite impure, containing hornblende, a little mica and considerable graphite. The attraction from the main pit southward to the house of Inschow is from five degrees to twenty degrees, positive. The ore appeared to be of good quality, and contains some manganese, but it is lean, and the extent is apparently quite limited. In a hole on Welch's lot the rock was also calcareous, and the ore similar to that on Inschow, but only thin strings of it were found. Some of the limestone ledges near this point contain brown-garnet and serpentine. Franklinite has been reported from this locality, but these reports are not authenticated by the specimens.

Stiff Farm.—This lies west of the road and west of the last mentioned locality, at the foot of the main mountain range. There are several openings, all of them in the coarse crystalline *dike* ore, consisting of feldspar (orthoclase), brownish quartz and magnetite. In one of the openings, the latter mineral very largely preponderates, occurring in irregular strings and sheets in the granitic matrix. The explorations were made about two years ago by Chas. Scranton, since which no further work has been done.

Potter Farm.—This property is owned by the Crane Iron Company. The mining here consists of a single pit in the valley between the mountain and a ridge bordering the great meadows. It is about a half mile northwest of the farm house. This shaft was put down fifty feet, and in it ore four feet in width was struck, said to resemble that of the Kishpaugh Mine. The attraction here is very light.

Garrison Farm.—North of the Potter Farm and east of the main mountain. Ore was mined here fifteen years ago, but since that, no further mining has been done. The opening was about half a mile northwest of the house, and near a small brook.

Davis' Mine, on top of the mountain west of A. Davis' house. When visited in November last, the shaft was twenty-five feet deep, and at the bottom there was a layer of ore a foot in width. The dip of the rocks was steep towards the southeast. Some calcite and a little pyrite in both the ore and the enclosing rock strata. Some chalcopyrite and azurite noticed. The latter in thin coatings in seams of the rock. On the hanging wall side, the amount of calcite is so large as to be called an impure limestone. These beds are interstratified with the gneiss.

Albertson Mine, on the mountain west of and about four hundred yards from Davis' shaft. These openings were made by Edward Bulgin, of Danville, within a year. The rock is a micaceous gneiss, dipping steep towards the southeast. Several narrow layers or sheets of ore are stratified with the rock. The locality has not been fully developed. According to an analysis of specimens sent to our laboratory by Mr. Bulgin, there are but traces of sulphur and phosphorus in this ore, and a little manganese.

Shaw Mine.—This mine is still idle.

Howell Farm Mine.—Under this head are included several openings, near the Howell farm house, on the north slope of the ridge and east of the main road, and several others in the hemlock woods, near the road. Some of these were made years ago, by Nathan Hopkins. The explorations were resumed in 1872, after the purchase of the property by S. T. Scranton & Company. The farm was visited in 1871, and carefully explored with the dipping needle. The observations then made were, that in the fields, near the old copper mine shaft, the line of attraction ran nearly north and south, and was most of the length which it was followed positive, but negative at the north end of the line. This line was, in places, seventy feet wide. The new shaft near the northern end of this line of attraction, found the vein ten feet wide. This width includes some calcareous rock—an impure limestone. The dip is about seventy degrees towards the southeast. An adit tunnel is now being driven in from the west to strike the vein below the bottom of this shaft, and so drain off the large amount of water which now impedes work. This will be about one hundred and fifty feet long. The rock is a hard, greyish, close-grained gneiss. A narrow trap dike was observed in this cutting. This tunnel is expected to strike two or more veins within fifty feet of the shaft, two of which are opened above on the surface. In the hemlocks, three hundred yards south-southwest of these openings, considerable sinking has been done, and a vein eight feet wide worked. Here the dip is about sixty degrees towards the southeast. A large amount of calcite and graphite accompany the ore. An analysis of the average ore of this mine gave the following percentages, viz:

Sesqui oxide of iron,	83.63
Oxide of manganese,	.65
Carbon,	.70
Phosphoric acid,	.10
Sulphuric "	1.09
Carbonic "	4.63
Titanic "	0.00
Silicic "	.60
Lime,	4.82
Magnesia,	1.22
Alumina,	2.67
	100.11

Metallic iron,	58.50
Phosphorus,	0.05

This mine is yet so far from railroad lines, that no ore has been sent away, and the explorations are going on slowly, waiting for the construction of the contemplated Pequest and Wallkill Valley Railroad.

WARREN COUNTY--EAST AND NORTHEAST OF THE GREAT MEADOWS.

Scranton's Lease, north of Danville, about a mile from Danville, and on the east side of the Great Meadows. A single trial pit found a good vein of ore. Nothing further is known of the locality.

Schaeffer Farm, two miles southwest of Warrenville. A little work done here in 1872 uncovered a small vein of rich ore. Latest reports say that it has pinched out.

Livsey's Mine, on the farm of Andrew Hibler, in Warrenville. About a dozen shafts have been sunk on this farm within a short distance (north) of Hibler's house. There appears to be a wide vein of ore-bearing gneiss—consisting of alternate layers of magnetite and rock, resembling the Henry tunnel ore and that on Shoemaker's, near Oxford. The strata dip steep towards the southeast. When visited the shaft then sinking was intended to go down through the hanging wall rocks to a richer ore.

This lean, banded ore and rock, (of which average samples were obtained on the ground) contains:

Magnetite,	26.95
Phosphoric acid,	1.02

or over seventy per cent. of foreign minerals.

Maring Farm, half a mile southwest of Warrenville. The explorations here were made by Richard Stephens, of Mount Hope, and resulted in opening some good ore. The line of attraction is long and constant. Southeast of this the Hibler line crosses this farm also, being traced by the outcrop for nearly a mile.

Haggerty's Diggings, north of Warrenville and west of the Alamuchy road—made by T. Haggerty, of Alamuchy. The work of breaking this ground consisted in digging narrow trench across the strike of the strata, down to the solid rock or ore. In this way the hill was pretty thoroughly tested at comparatively small expense. No large veins were found, but several small ones and strings of ore.

SUSSEX COUNTY.

Glendon Mine.—This old mine has not been worked for several years. With the ore there is a large amount of calcite, and it contains some oxide of manganese. Of the extent of the ore nothing was learned.

Andover Mine.—The old mine remains as it was left years ago. Towards the northeast, what is known as the *Sulphur Hill Mine*, was worked two years ago for a Harrisburg furnace. The ore was very full of sulphur. The place was abandoned over a year ago.

Roseville Mine.—This mine was visited last summer, but no mining was in progress, and the works appeared to be abandoned.

Tar Hill Mine.—Not working.

Franklin.—The vein of ore in the white limestone has been worked largely, near the Wallkill, and to some extent on the high part of Mine Hill. The mines in gneiss are not worked at present.

Green's Mine, on Pockhuck mountain, near McAfee valley. Nothing has been done here in many years.

Bird Mine, on Pockhuck mountain. This too is idle.

HEMATITE IRON ORES.

The mines of this ore of iron now worked in the State are comparatively few and at widely separated points.

Pochuck Mine.—This old and well known mine belonging to the Franklin Iron Company is being put in working order by the completion of a new slope, heavy pumping and hoisting machinery, and by the construction of a gravity railroad over the ridge eastward, down to the railroad at McAfee Valley. These changes will afford easy and extensive facilities for mining on a large scale. The blowing in of the furnace at Franklin will set the work going.

Cedar Hill or Ten Eyck Mine.—This is a new opening on the brow of the steep limestone ridge west of McAfee Valley. It was opened about three years ago by Mr. Ten Eyck, of Warwick. The Franklin Iron Company has quarried out several thousand tons of lean ore, which is still at the mine. Its geological relations are strange, and not well understood. The ore appears to have all been worked out.

Beattyestown Mine.—Here the Musconetcong Iron Works Company is working for the Stanhope furnaces. The prospects are very fine, and the ore of excellent quality.

German Valley.—The explorations here have not been continued this year. Upon the completion of the High Bridge and Chester Railroad, they will be further continued and probably worked.

Carpentersville—This mine is reported steadily working.

New Village.—A mine of hematite is reported as recently opened near this village. It has not been visited.

Shiloh, near Hope, Warren county. A little hematite was found the past summer in some test pits dug on the farm of a Mr. Burdge at this place, but no workable amount. The locality is at the western foot of the Jenny Jump Mountain and near the boundary line between the gneiss and the blue limestone.

Bird Mine,—This deposit of hematite is on the farm of B. Bird, about a quarter of a mile west of Clinton, Hunterdon county. It was opened the past year, and worked by G. M. Conover and J. K. Large until stopped by the panic in September. It lies in the blue limestone near its junction with the red shale. The covering of earth at the north end of the pit was slight. Southward it increases, the ore appearing to dip in that direction. About two thousand tons of wash and lump ore have been taken out of this main excavation, which does not yet exceed twenty feet in depth. From test pits sunk near this, the quantity of ore is considered large, belonging to a single body or pocket rather than detached masses. So far, only about one-fourth of the ore raised needed washing. The short time which this mine has been worked explains the lack of deeper and more extended excavations.

SEARCHING FOR NEW BEDS OF IRON ORE.

With the rapid increase in our yearly production of iron, and the prosperity of the mining interest, there has been a very general inquiry for new locations for mines, and an active search for new beds of ore. The owners of old and established mines pursue their inquiries and searches with prudence and intelligence; but a great deal of money is wasted in useless or injudicious explorations, by inexperienced and sanguine persons, who know the value of mines, but have not learned the difficulties of finding them. The following directions to those who are looking for iron-ore deposits may be useful.

1. *The workable beds of magnetic iron ore are all in the Azoic rocks.*—Strong local attraction is not uncommonly found in the trap rocks of our state, and some attempts have been made to work them, but as yet without success. The ore in the trap is disseminated everywhere through it, but has not yet been profitably separated from the rock.

2. *The magnetic iron ore is all found in beds which are interposed between the layers of the gneiss and are conformable to them.* It is never in veins which cut across the layers of the rock; it has no gangue rock of calc spar, fluor spar, quartz or any other mineral different from the common minerals of the adjacent rock layers; it has no rock walls by which the ore is separated from the adjacent rock, which at all differ from any other two adjoining beds of rock which are separated by a seam of softer or otherwise different mineral, and in many cases there is no seam at all, but the ore adheres firmly to the rock; and there are many instances in which it passes into rock by a gradual diminution of magnetite in the mass. These beds of magnetite, like the rocks among which they occur, are highly inclined or almost vertical. In this respect they have an acci-

dental resemblance to true veins, and this has led to their being commonly called *veins.* And, understanding that the word vein, simply means a flattened mass of ore standing on edge, the name may be accepted without conveying a wrong impression.

3. *Since the layers of ore and rock stand on edge, it necessarily follows that the ore must come to the surface of the rock.*—The rock surface is usually covered with loose earth and boulders, and of course this outcrop of ore is hidden from sight. But it is only necessary to remove the loose earth, in order to determine whether the ore is there. Blasting out or sinking expensive shafts in rock is not necessary, and such expense should not be incurred in ordinary explorations.

4. The direction in which the beds of ore *range* is the same with the strike of the rock, and the extension of worked beds of ore is frequently proved by ranging, and many successful searches for new openings upon ore have been made in this way.

5. *In ordinary cases where the surface is covered with loose earth it is common to search for ore with a magnetic needle or a miner's compass*, and for preliminary examinations it is now the chief reliance. In using this instrument much practice is required; but this joined to good judgment gives indications of the presence of ore which are almost infallible. The importance of this mode of search is so great that we may describe the instruments, their indications, and the mode of using them, at some length.

Instruments.—The surveyor's compass with a horizontal needle was the instrument first used for detecting and locating beds of magnetic ore, and it may still be used for that purpose, but it is unnecessarily large and heavy, and searches with it go on slowly. Pocket compasses, or those having needles only two or three inches long, which are without sights and so light as to be held steady in the hand, were used very generally till within the last five or six years. As indications of less than two or three degrees were not noted, these instruments were sufficiently large, and much good work was done with them. They may still be used to advantage, but have gone into disuse mainly because another form can be used which gives indications more rapidly.

The Miner's Compass, which is the one now most generally used, has a magnetic needle balanced on a *horizontal axis* so that the needle itself may turn up and down instead of sidewise as in the other form of compass. Such a mode of suspension constitutes it a *dipping* needle. The needles used are from two to four inches long and are hung in circular boxes having brass edges and glass sides. The needle is suspended in the middle of the box, and the box itself is held by a ring attached to its edge. The circular edge is graduated inside to degrees, and these are numbered so that when the needle is level it points to 0°, and when it dips down vertically it points to ninety degrees. The box must be held so that its faces are towards the east and west, the needle is balanced so as to be horizontal when in this position, if there is no local attraction. If the box does not face east and west the needle will not be horizontal even if there is no local attraction, so that caution must always be exercised when making observations with it. There is a Swedish compass for miners which has both horizontal and vertical motions, and is most approved there. It has not the steadiness of our instruments, however, and cannot be used with so much confidence in its indications. Messrs. W. & L. E. Gurley, of Troy, have made for me a miner's compass which has the two motions, dipping perfectly and having sufficient horizontal motion to prevent making mistakes in holding the compass. It is mounted in a box like the common miner's compass, and I have no doubt is the best that has yet been invented.

All the compasses need handling with care, they are very delicately suspended, and can easily be broken, worn or displaced. The magnetism of the needle may also be diminished or weakened. If the compass is out of order, the only safe way is to send it to an instrument maker for repairs.

Indications.—It is well known that if a bar of iron is held perpendicularly, it acts like a magnet; its upper end attracting the north end or pole of the compass needle, and its lower end the south pole. If the upper end of the bar is leaned over towards the south about twenty-five degrees in this latitude, its magnetic properties are developed most powerfully, and on the contrary if the bar slants away from this position it shows its magnetism less strongly, and when it lies horizontal in an east and west direction it shows no magnetism at all. This magnetism in the iron bar which is developed simply by its position, is considered to be due to the influence of the earth. Magnetic iron ore is susceptible of being made into magnets by the influence of the earth, the same as the iron bar. The beds of ore are like great flattened bars of iron which stand on end with their upper extremities slanting towards the southwest, and their lower ends extending down into the earth towards the northeast. Their upper ends which, of course, are those under the soil but nearest the surface, should attract the north end of the needle, and this they always do. If the bed of ore is broken across by an offset, or its continuity destroyed in any other way, the lower end next this break or offset should attract the south end of the needle, and this it always does if the break or offset is near enough to the surface to move the needle in any way.

Again, if a bar of iron is laid down with its ends pointing north and south, the north end will attract the south pole of the compass needle, and the south end of the bar will attract the north pole. In crossing a vein of magnetic ore from the south towards the north, the north pole of the needle is attracted during all the first part of the passage, but just at the place of passing off the vein the south pole of the needle is attracted; a short distance further all attraction ends, all of which is quite in accordance with the experiment with the bar of iron. The attraction which draws the north pole is often spoken of as *positive;* and that which draws the south pole as *negative;* and in writing, these attractions are expressed by the algebraic signs, plus and minus.

The indications from the magnetic needle, in searching for ore as it usually occurs in our State may be stated as follows:

An attraction which is confined to a very small spot and is lost in passing a few feet from it, is most likely to be caused by a boulder of ore, or particles of magnetite in the rock.

An attraction which continues on steadily in the direction of the strike of the rock for a distance of many feet or rods, indicates a vein of ore; and if it is positive and strongest towards the southwest, it is reasonable to conclude that the vein begins with the attraction there; if the attraction diminishes in going northeast, and finally dies out without becoming negative, it indicates that the vein has continued on without break or ending until too far off to move the compass needle. If, on passing towards the northeast along the line of attraction, the south pole is drawn down, it indicates the end of the vein or an offset. If, on continuing farther still in the same direction, positive attraction is found, it shows that the vein is not ended; but if no attraction is shown, there is no indication as to the further continuance of the ore.

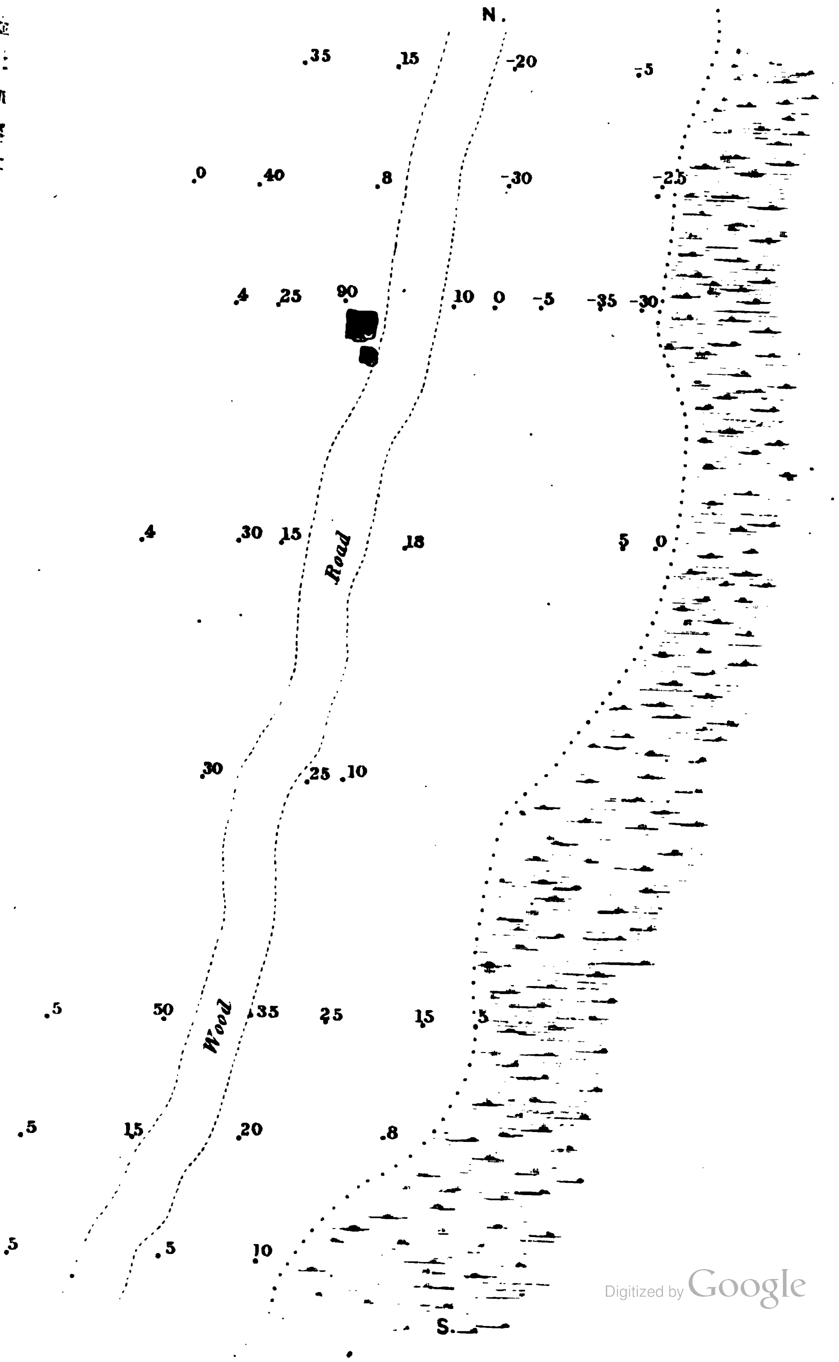
In crossing veins of ore from southeast to northwest, when the dip of the rock and ore is as usual to the southeast, positive attraction is first observed to come on gradually, as the ore is nearer and nearer to the surface, and the northwest edge of the vein is indicated by the needle suddenly showing negative attraction just at the point of passing off it. This change of attraction will be less marked, as the depth of the vein is greater, or as the strike is nearer north and south. The steadiness and continuance of the attraction is a much better indication of ore, than the strength or amount of attraction is. The ore may vary in its susceptibility to the magnetic influence from impurities in its substance; it does vary, according to the position in which it lies—that is, according to its dip and strike; and it also varies very much according to its distance beneath the surface.

Method of Using the Compass in Searching for Ore.—The following maps of surveys for ore, illustrate the methods pursued, and do away with the necessity for much explanation. It is sufficient to say that the first examinations are made by passing over the ground with the compass, in a northwest and southeast direction, at intervals of a few rods, until indications

MAGNETIC SURVEY,
GAFNEY FARM, BYRAM TOWNSHIP, SUSSEX COUNTY.

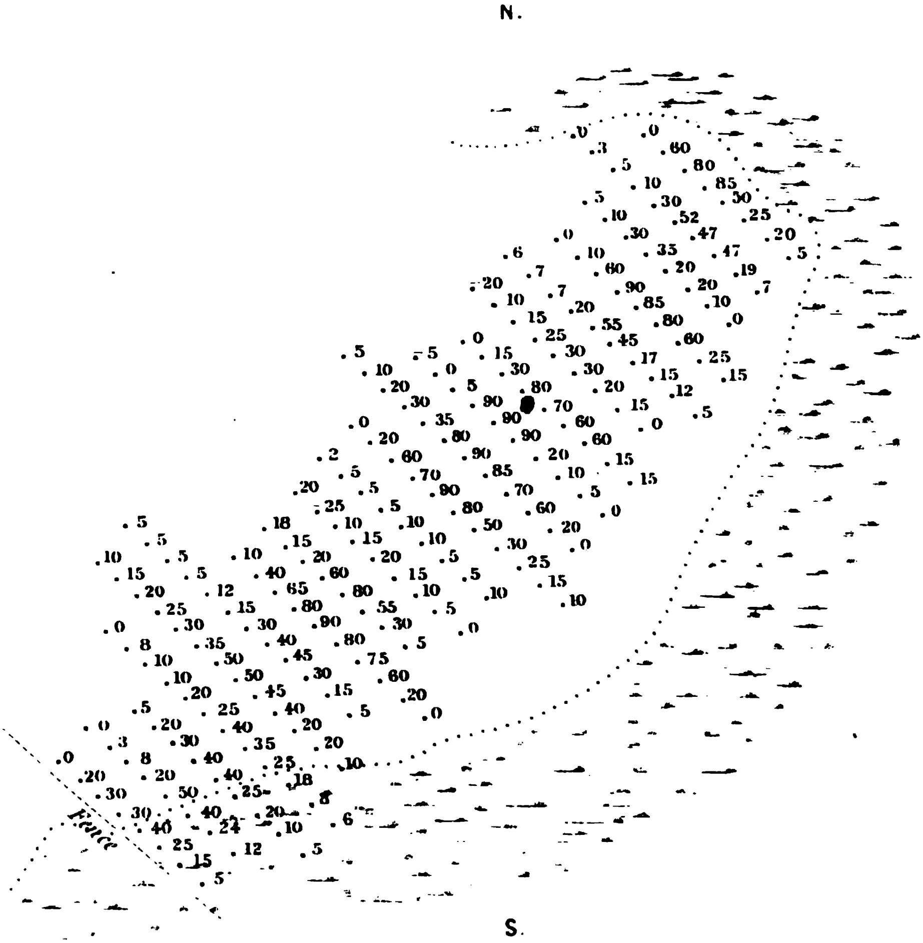
Scale 80 feet to one inch.

— indicates negative attraction.



MAGNETIC SURVEY,
LANDS OF SCRANTON & RUTHERFORD,
WEST MILFORD TOWNSHIP, PASSAIC COUNTY.

Scale 80 feet to one inch.
— indicates negative attraction.

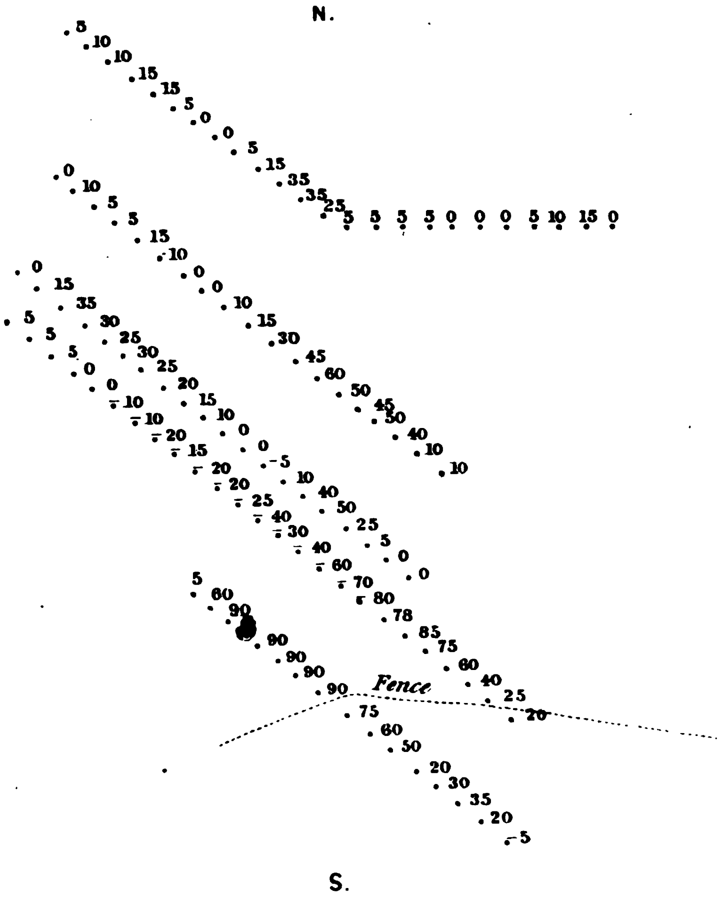


MAGNETIC SURVEY,

LANDS OF SCRANTON & RUTHERFORD, WEST MILFORD TOWNSHIP, PASSAIC COUNTY.

Scale 80 feet to one inch.

— indicates negative attraction



of ore are found. Then the ground should be examined more carefully by crossing the line of attraction at intervals of a few feet, and marking the points upon which observations have been made, and recording the observations. In this way, materials may soon be accumulated for staking out the line of attraction, or for constructing a map for study and reference.

After sufficient exploration with the magnetic needle, it still remains to prove the value of the vein by uncovering the ore, examining its quality, measuring the size of the vein, and estimating the cost of mining and marketing it. Uncovering should first be done in trenches dug across the line of attraction, and carried quite down to the rock. When the ore is in this way proved to be of value, regular mining operations may begin.

In places where there are offsets in the ore, or where it has been subject to bends, folds or other irregularities, so that the miner is at fault in what direction to proceed, explorations may be made with the diamond drill.

In the report for last year, this was urged upon the attention of capitalists and mining engineers interested either in working the large mines or in the examination of unexplored territory. During the year past, the diamond drill has been employed at two points in Pequannock township, Morris county, in searching for ore. The work was under the direction of J. W. Hussey, of Bloomingdale, who has kindly furnished the following results: On the Kahart farm, about three miles southwest of Bloomingdale, five holes were bored on the line of the supposed vein, and at distances thirty feet apart. The holes were vertical. In each of these the vein was found and from the core its thickness and degree of dip were ascertained. The depths at which the ore was struck, ranged from fifteen to ninety feet beneath the surface. The dip was reported as fifty degrees towards the north. This unusual direction or inclination of the ore is also seen in the old mine holes on the same line on this farm.

The other line tested was two miles northwest of the Kahart farm, and near Stony Brook, on lands of Abraham Gould. Here three vertical holes were bored, and ore found in each of them.

The rock was a very hard gneiss. From the experience gained here, Mr. Hussey says that in ordinary gneiss rock holes can be put down eighty feet deep at a cost of $3.00 per foot, and fifty feet at $2.00 per foot. provided there is an adequate supply of water near, for running the drill. From these results and from the successful employment of the drill, in testing the extent of iron ore beds on Lake Champlain, New York, and Cornwall, Pa. and in boring for coal in the latter state, it can be safely recommend, as not only cheaper, but also much quicker, especially when the examinations are to be at all deep. And "time is money." The American Diamond Drill Co., of New York, agree to put down holes not exceeding three hundred feet for $6.00 per foot. Under favorable circumstances this drill will bore thirty feet in a day. As the boring deepens this rate is much less. Near Pottsville, Pa., the drill has been employed to bore several holes preparatory to sinking shafts. Several contiguous holes were bored and then filled with sand, quite to the top. This was removed in lengths for a cartridge of nitroglycerine, which exploding, tore up the rock about the size of the shaft. The core brought up by the drill shows the character and thickness of the successive beds pierced as also the amount of the dip, but not the direction. Wherever a great thickness of rock lying over a supposed vein is to be penetrated this is the cheapest and quickest mode of determining the extent and character of the ore. And in case of some of our larger mining companies, such an examination of property might develope large extent of ore, justifying machinery and modes of working commensurate with the amount of work before them. In some instances this would be more economical than the falsely conservative plans now followed.

At two other points, the use of this drill had been decided upon, but the financial difficulties so severely felt by iron mining companies prevented the trial.

The subject is earnestly and urgently commended to all our iron-mine superintendents, and to capitalists or others connected with mining or prospecting for ore.

Searching for Hematite ores cannot be done with the miners compass. The ore does not affect the magnetic needle. All the deposits of this ore yet known in New Jersey have been found in or near the magnesian limestones. Nearly all have been found at the meeting of the limestone and the gneiss rock, though a little has been seen near the meeting of the limestone and the slate. To search for this ore, the first requisite is to be familiar with its appearance, so as to recognize it even in very small fragments. The next point to be attended to is the geographical position of the magnesian limestone. This is accurately laid down upon the map accompanying the present report. A careful examination of the surface of the ground where hematite exists, will detect fragments of the ore among the little stones and gravel that may be exposed; and in some cases pieces of the ore weighing many pounds are found loose upon the surface. Very full directions for sinking trial pits in the search for hematite, were given in the Geological report for 1872, and the reader is referred to that for particulars.

ZINC ORES.

The mines of zinc ore at Franklin and at Stirling Hill continue to be worked. The Lehigh Valley Railroad Company, the lessees of the Morris Canal, report that they have transported on the canal the past season seventeen thousand five hundred tons of zinc ore. This has been carried to the New Jersey Zinc works in Newark, and the Passaic Zinc Works in Jersey City, where the ores are reduced.

The extraordinary richness and value of these mines has stimulated the search for other deposits to a remarkable degree. We are continually receiving specimens to test, which have been taken from new localities, with the hope that they might prove to be valuable zinc ores, but so far, we have not found any new ones of value. Boulders of ore from Franklin or Sterling zinc veins are found scattered among the gravel and loose earth for several miles south and southwest of these veins. One near Sparta weighs as much as a hundred tons. Fragments of this easily recognized ore have been sent to the office of the Survey from places twenty or even thirty miles from the mines, but it is suspected that they have got there by accident or by fraud, as no considerable quantity could be shown.

The hydrous silicate of zinc or calamine has a close resemblance to gray limestone, and many samples have been sent here to be tested. None of this ore, however, has been found in the State except at Sterling Hill, where it is mined by the Passaic Zinc Company.

Zinc blende has been sent to the office for examination. It was taken from some place on the Blue mountain in Warren county. From the specimens seen, there is nothing to encourage the search for more at that locality. The mineral in small quantities is not uncommon, but it is uncommon to find it in sufficient quantity to work. Searches will undoubtedly be continued at other places along the Pequest Belt, in the range of the zinc mines now opened—and as the oxides of iron and manganese which accompany the zinc at those mines, are found throughout the whole length of the belt in New Jersey, it is possible the zinc may be found also. It may facilitate the work of those who wish to make such searches to know that the veins both at Stirling and at Franklin, affect the compass needle, and though the attraction is not very strong, it is just as decided as it is over iron ore veins. Ore supposed to contain zinc is easily tested at a blacksmith's fire. The ore should be crushed fine, then if thrown upon the clear-burning red-hot coals, and the bellows blown, there will be an abundant white smoke, which is oxide of zinc.

COPPER ORES.

Ores of copper are very common in the red sandstone or triassic rocks of Central New Jersey, especially near the meeting of the sandstone and trap. They are very lean and irregularly distributed through the rocks, and no regular veins or beds have yet been found in the state. Failures in the attempt to work them profitably, have been very numerous, though some persons still make the attempt. But the work is not promising, and we discourage any investment of money in our copper mines in the present condition of the metallurgy of copper. It is reasonable to hope that the art will yet so improve that our ores will be valuable.

GOLD AND SILVER ORES.

Many specimens of ore said to contain silver, have been brought to the office, but in none of them has any silver been found. Some came from the copper ores, some from the gneiss rocks of Schooley's Mountain, and a number from Jenny Jump. The reports of silver being found in the localities which these specimens represent are either intended for practical jokes or else they are frauds.

Gold in very small quantity has been found in some of the iron pyrites of the Blue Mountain in Sussex and Warren counties; but only just enough to prove it was there, and as specimens were tested from different places, it is considered very unlikely that gold in paying quantities will ever be found in those rocks.

BUILDING STONES.

Few new localities for quarrying stone for building purposes have been opened during the year. One of these visited was on the farm of M. J. Ryerson, near Bloomingdale. It is on the southern end of a rocky ridge about one-quarter of a mile east of the village and on the north side of the Pequannock River. The rock is grey gneiss, consisting of flesh colored feldspar, vitreous quartz and brown-black mica. The proportion of the mica varies considerably, being quite abundant in some of the beds, while in others only occasional plates are seen. The dip of the strata is very constant, from fifty to sixty degrees towards the southeast. Two systems of joints traversing it at right angles to the plane of the dip split it into very large rectangular blocks, which are easily divided into smaller and more convenient sizes on lines parallel to these natural planes of division. The beds which crop out on the summit of this ridge are but slightly rounded on their edges and have retained their original fresh shades of color on the outside, showing no tendency to weather readily or to suffer from oxides or sulphides of iron so generally present in our gneissic and granitic rocks. Large sizes for foundations, sewer covers, &c., are easily got out. The smaller stones are used for paving blocks. They are split into oblong masses and are used for the so called granite block pavement. A few car loads have been sent to Paterson for trial. They can be delivered at the railroad station, Bloomingdale, at $70 per thousand. By transfer to canal at Mead's Basin the transportation to Newark and Jersey City need not be very costly. Northeast of the quarry the stone is for a long distance remarkably even-bedded and appears equally well adapted for building as that at the south end of the ridge.

Ryerson's Granite.—This is on the north side of the Pequannock river, about three-eighths of a mile east of Charlotteburgh, and forms huge ledges in the steep hill above the road. This rock is a mixture of flesh-colored and white feldspar, quartz, quite clear, and black amphibole—more properly a syenite than a granite. The mass has a greyish color and resembles the Scotch granite. The stone split easily on long straight lines and are susceptible of a high polish. The supply of such stone is practically inexhaustible.

South of the river, opposite the granite, above the railroad, there is an old quarry worked by the railroad company for heavy stone for bridge abutments. The rock here is a grey gneiss, with a dip very distinctly seen towards the southeast. The railroad being below and near it, and abundant water-power at the river for sawing, dressing and polishing, this locality offers rare advantages for supplying heavy stones.

Bennett's Quarry, Deckertown.—About one mile southeast of Deckertown, and at the side of the Midland Railway track, a new quarry has been opened during the year and worked to some extent by E. P. Bennett. The stone is the ordinary blue, magnesian limestone, but quite remarkable for its regular bedding and for the ease with which it can be dressed. The strata dip twenty-five degrees north fifty degrees east, and range between five and thirty inches in thickness. Stone from three to five feet wide are readily got out. The *spalls* go to a kiln to be made into lime. A few stone have been sent away, but the business is hardly yet started. When visited in December there were about fifty car loads on the bank. A switch from the main track running into the quarry affords ready means of shipment.

The quarry in the gneiss near Dover continues to be worked and a large amount of stone is taken from it every year for heavy work, for which it is admirably adapted.

There are many other points along our railroad and canal lines where gneiss suitable for building stone can be quarried, and its strength, durability and beauty commend it to the attention of builders. In selecting sites for quarrying careful examination should be made so as to avoid stone liable to disintegrate readily. Stone containing iron ore, iron pyrites or any sulphides of the metals is also to be carefully avoided, as such are quickly stained by weathering or even liable to partial disintegration. A little attention to the character of outcrops will determine in many cases the probable value of the stone at any given point. Where the stone has been covered by earth and boulders and so protected from atmospheric agencies a chemical examination will very quickly settle the question.

The employment of stone from iron mines, which under certain circumstances economical, is not however, to be recommended, from the extremely probable occurrence of ore or pyrite in it, which on long exposure would weather to a rusty-brown oxide, spoiling the appearance of the stone.

The brown stone so well known for its adaptation to the purposes of the architect and the engineer, continues to be quarried in large and increasing quantities. The most of the quarries which are largely worked, are on the Delaware or along the Passaic, where, by canal or river, the advantages of cheap transportation can be secured. From our location, in regard to the great cities of the country, we have peculiar facilities for supplying this excellent building material, and the localities from which it can be obtained may be greatly increased by a careful examination of the red sandstone country that is traversed by our numerous railroads; and the variety of shades of color which it presents may be much increased.

An attempt was made to collect the statistics of the amount quarried at different points, but for want of time it has not been completed. Through the favor of Ashbel Welch, Esq., Engineer of Construction for the Pennsylvania Central Railroad in New Jersey, we have estimates of the amount quarried at Prallsville, on the Delaware, as follows:

The R. R. Co.'s quarries yielded	8,700	perches of 25 cubic feet,
Kessler's (Hoppock property), "	18,300	" " "
Five other quarries, aggregate "	8,600	" " "
Total, - - - -	35,606	" " " .

Of these, about half went to Philadelphia for bridges, &c.; nearly a quarter was used by the Pennsylvania Railroad Company, as much by the Easton and Amboy Railroad, and a small quantity elsewhere. The value of these stones at the quarry before being dressed, was not far from $80,000.

From Messrs. Prior & Son, of Trenton, we learn that the quarries about Greensburg yield sixty thousand tons annually, estimated to be worth $90,000.

The quarries of free stone, at Newark, Belleville and Paterson, are steadily worked, the average sales per year for the past six years having been as follows:

Newark, - - - - - - - -	$100,000
Belleville, - - - - - - -	100,000
Paterson and Oldham, - - - - -	40,000

At Little Falls there is not so great activity in quarrying, and the annual sales average about $10.000.

These items were furnished by Robert Matches, Esq., of Newark, who is interested in the Newark quarries.

Clays.—The plastic clays, including the varieties known as fire clay, porcelain or china clay, paper clay and alum clay, extend entirely across the state from Raritan Bay and Staten Island Sound on the east, to the Delaware river on the west. The northern limit is marked by the outcropping red shale and sandstone of the triassic formation, following an almost straight line from Woodbridge, southwest by Bonhamtown, to the mouth of Lawrence's brook on the Raritan river; along this stream nearly to Monmouth Junction; and thence north of the railroad, near Penn's Neck and Baker's Basin, to the Delaware river at Trenton. The southern boundary of this sub-division of the cretaceous formation is not so well defined in consequence of the superficial beds of drift which cover it. Near Raritan Bay these are not so thick, and the division line between the plastic clays and the clay marls, is accurately located near the mouth of Cheesquake creek. But towards the southwest, the overlying drift is so deep that it is impossible to draw the southern boundary with much certainty. The pits where these clays are dug are confined to limited areas near Woodbridge, Amboy, Bonhamtown, Washington and Trenton. During the past few years the increasing demand for these valuable clays has stimulated searches beyond the old clay districts, and resulted in the discovery of additional localities where they can be profitably dug. The several pits between Staten Island Sound and the Raritan river, indicate a continuous and quite regular bed of clay under the surface beds of soil, red shale drift, sand and gravels. There may be points in which this continuity is broken, in consequence of the removal of the bed previous to the deposition of the newer and overlying drift materials. This is evident to all who are engaged in clay digging, to whom the very uneven upper surface of the clay is a striking and well-known feature. Such points of interruption in the bed are exceptional, and the probability of their occurrence not strong enough to deter explorations anywhere within the limit of this geological belt; and the thorough examination of this whole territory is here urgently recommended to land-owners and others interested in the clay business. In this examination, regard should always be had to the probable thickness of the overlying deposits and the searches should be made in the lower grounds along the streams or near the red shale border where the bed crops out nearer the surface. Boring is the quickest and most economical mode of searching. Where there is no danger of quicksand, test pits or wells are almost as cheap and more thorough and satisfactory than borings. These should go down at least forty feet where new territory is being examined. Near old pits, less depths may be equally conclusive. In some cases this depth may be exceeded; as for example, near Woodbridge where the bed worked is so valuable as to make the removal of a greater thickness of top earth possible with profit.

Associated with these clays, *fire sand*, *moulding sand*, *kaolin* and *feldspar* often occur, and in quite thick beds. All of these are employed with the clays in various manufactures, and in such connection their extraction is profitable. Improvements in the modes of manufacturing refractory materials will undoubtedly increase their uses and make them everywhere worth digging.

Between the Raritan river and Trenton, there is a wide gap in which no valuable clay has been dug. Borings along the streams or in the depressions in this district may yet discover workable beds. The wells cannot be regarded as test pits, as they rarely go through the drift. The examination by boring of some of the more favorable localities would be interesting and probably find clay of value. The old and well-known clay pits continue to be worked with great activity. During the most of the year, the great demand for fire brick made the clay trade very brisk, and the amount of clay dug was large. The financial crisis affecting the metallurgical industries of the country, is equally depressing upon the clay business; but this will probably be temporary, and the re-establishment of business may accrue to the advantage of this interest by making the superior character of our clays more widely known and more generally appreciated.

For the details of localities the reader is referred to the Geology of New Jersey, and for modes of searching for clays, to the Annual Report for 1872, pages 24–26.

Glass Sand.—The manufacture of glass in the southern portion of the state, continues to be thriving, and the supply of sand suitable for it appears to be ample for all prospective demands. During the past year some boring was done near Winslow, on lands of Hon. A. K. Hay, to determine the area of surface from which sand could be profitably obtained. The results were highly satisfactory and showed the value of this mode of exploration. Its employment would doubtless increase the number of localities which could be profitably worked for this valuable material.

In the northern portion of the state sand for glass making has been obtained in quantity at one point only, viz: near Flanders, Morris county. It was worked fifty years ago for a glass house, at Columbia, Warren county, on the Delaware river. The sand was hauled this long distance by teams, crossing Schooley's mountain, through Hackettstown, Vienna and over the Jenny Jump mountain to the Delaware, and a good quality of glass was made from it. The pit is now owned and worked by the Boonton Iron Company. If valuable for glass the supply would be large, as the whole ridge in which the pit is located consists of this friable *sand rock*. For full description, see Geology of New Jersey, pages 93, 693 and 694.

Another glass sand locality is near Sand pond, on the Blue mountain, Hardwick township, Warren county. It was worked for the Columbia glass house, but only to a limited extent.

LIMESTONES.

Lime was the first of the fertilizers brought in to supplement the farmers' home supply of manure, and it still holds a very important place in the list of commercial manures. In those parts of our state where agriculture is the most improved, lime is still considered a necessary adjunct to the other supplies of manure, and it is regularly and largely used. Our best farmers know that they get better crops where lime is judiciously applied than where it is not used at all; that weeds are less abundant and troublesome; that pastures are thicker, richer and more luxuriant; and that clover grows best on such lands. It is greatly to be desired, that an abundant supply of pure and cheap lime should be easily obtained in all parts of the State, and we look with much interest on the large addition made to our sources of supply by the opening of the Midland Railroad across the county of Sussex. From Ogdensburg to Franklin much of the road bed is on crystalline limestone, and it runs near many other fine exposures of the same between the last named place and Deckertown. Near McAfee Valley the White Rock Lime and Cement Company have started a kiln and are burning about thirty barrels of first quality lime daily, and about one-fourth as much of lime for farmers' use. This lime is pronounced by those competent to judge as quite equal, if not superior, to the best lime found in New York market, and its nearness to that great centre gives it an advantage in price over any of the others. There is an unlimited supply of white or crystalline limestone in this part of Sussex county, as indeed there is along the whole length of the Franklin belt from the New York boundary to the Delaware, and it must soon attract the notice of manufacturers and consumers of lime.

The farmers of Sussex have made less use of lime than most others. The production of an abundant supply of the best quality of this fertilizer should stimulate them to its more common use. It should be tried on pastures, spreading from fifty to one hundred bushels of the fine slacked lime on an acre, in the fall or winter; on sod to be turned over for corn planting, the lime may be used in the same way, or it may be spread on the plowed ground and worked in by harrowing. It can be used on plowed ground for wheat or rye with advantage.

The white limestone is in considerable part, though not all, pure limestone; the blue limestones east of the Blue mountain, are nearly all magnesian limestones. There has been much question among farmers as to which is the best. In places where lime has been most used, it is conceded that pure lime is quickest in its action, but that the magnesian lime lasts the longest. In buying unslacked lime there is no question but what a bushel of pure lime is worth more by at least one-third than the magnesian lime; but after they are slaked the pure lime swells so much more than the other that there is very little difference in their value, by the bushel.

Wallkill Cement and Lime Company.—This is an association started by John H. Brown, at Hamburgh, Sussex county, for the manufacture of hydraulic and other limes. Their quarry is on the side of the New Jersey Midland Railway, about a quarter of a mile northwest of the Hamburgh Railroad station, and on the southwest point of the Pochuck mountain range. The railroad cut, crossing the ridge near its terminus at the Wallkill, shows on the southeast a grey feldspathic gneiss a few feet in breadth whose dip is towards the southeast at a high angle. Going northerly this rock is followed by a few feet where no rock appears. This is succeeded by ledges of highly siliceous and conglomerate rock interstratified with more calcareous beds, followed by blue limestone, and the strata which are known as cement rock. Two principal varieties of stone are recognized as suitable for cement, a dark colored containing thin seams and nodular masses of calcite traversing the black or greyish black mass. These strata vary from fifteen to eighteen inches in thickness, and dip forty degrees west. On a line measured across the strata horizontally, these cement layers are not over thirty feet from the gneiss, so that geologically these lie closely and conformably upon the siliceous beds which probably belong to the Potsdam epoch. This dark colored rock is very hard, brittle, and breaks with a subconchoidal fracture. About one hundred feet from the gneiss at the west end of the cut, the light colored stone crops out. The same variety is seen in the newly-opened quarry on the north side of the railroad track. As here exposed, the strata of this variety occupy a breadth of ten feet between beds of quartzose black slaty rock, with thin sheets and layers of the same slaty rock at irregular intervals, interstratified with it. This light colored cement stone has a finely laminated structure due to alternations of darker and lighter shades of material. In this it resembles closely some of the so-called ribbon limestone of the hills west of the Blue mountain. Some pyrite was observed in the more slaty beds as well as in the dark colored cement rock. For grinding and burning, the material is taken to "the Stone mill" south of Hamburgh, where a small kiln has been erected and two run of stone put in the mill for grinding the burned cement. Coal dust and screenings are used to burn it. The grinding capacity of the cement mill is said to be two hundred and fifty barrels, each per ten hours' run. Thus far the manufacture has been of an experimental character, and very little of the cement has been put in the market. From the very limited trials given it, there are favorable reports as to its ease in working and durability. Robert H, Howell, of Hamburgh, is president and manager at the works.

Samples representing the two varieties of cement stone, were obtained at the quarry, which have been examined, with the following results:

ANALYSIS:

	(1)	(2)
Carbonate of lime,	42.28	47.40
Carbonate of magnesia,	33.26	37.19
Silicic acid,	15.70	7.02
Oxide of iron and alumina,	6.00	5.43
Potash,	1.34	1.04
Magnesia,	0.36	0.68
Carbon,	1.35	1.17
	100.09	99.93

The analysis of these stones shows them to be impure magnesian limestones. They contain more magnesia than most of the cements which are in common use. Experience proves that they do not slake when burned, and that when ground and made into mortar, they quickly set and become hard, as cements should. Their peculiar properties will become better understood by a longer trial. Every effort to make good and cheap cement should be encouraged. The uses for it are increasing every day. For ordinary masons' work, it is rapidly taking the place of quick-lime. It sets quicker, so that work can be safely put up faster; it is much stronger, so that thinner walls can be used in many cases, and a great saving of labor and material effected; and water does not hinder its setting, nor weaken or in any way damage the mortar made with it. South of the mill the Sussex Extension and the Midland Railroads both cut a magnesian limestone, dipping forty degrees to fifty degrees towards the northwest. Some of the strata here are light-colored and resemble that at the cement quarry; but a short distance south and east of this, the white crystalline limestone outcrops, showing that the blue limestone of these cuts is nearly of the same geological horizon, and, therefore, similar in character to the cement quarry beds.

GREEN SAND MARL.

This fertilizer, which has been of such great value to the agriculture of our State, continues to be dug in large quantities.

The Squankum Marl Company, W. E. Barrett, Superintendent, report their sales for the year at three hundred and fifty thousand bushels, which is seventeen thousand five hundred tons. It is largely used on the line of the New Jersey Southern Railroad and its branches, and is applied with beneficial effects on crops of all kinds, especially on wheat, buckwheat, potatoes and grass. A luxuriant growth of white clover follows it wherever applied; fruit trees and vines make a remarkable growth, and produce fruit of high flavor when liberally dressed with this marl.

The Squankum and Freehold Marl Company, A. A. Yard, Superintendent, report their sales for a little over nine months of the year at twenty-two thousand tons. In addition to their sales in New Jersey they have shipped to Massachusetts, Connecticut, New York and Pennsylvania. The good effects of the marl are well known and highly appreciated.

The Cream Ridge Marl and Transportation Company, N. S. Rue, President, report their sales for the year at fourteen thousand eight hundred and forty-six tons, which has been mostly delivered on the line of the United Railroads of New Jersey and their branches. The largest part of it is spread upon grass land, though it is also used upon corn, wheat and potatoes with flattering reports of its results.

The Pemberton Marl Company, J. C. Gaskill, Superintendent, report their sales for the past year at twenty thousand tons. Their marl is delivered along all the railways which cross western Burlington. It is sold at prices ranging from eighty cents a ton upwards, according to the distance from the pits at Birmingham. Large quantities of it are used in compost with barnyard manure, by those who raise truck. It is used in the hill on potatoes, without compost, and it is spread clear upon grass, wheat, oats and buckwheat.

The Vincentown Marl Company, H. J. Irick, Treasurer, report that their sales this year are nine thousand four hundred and twenty-six tons. In addition to the sales in Burlington county this marl has been used about Hightstown, Windsor, Yardville, Princeton, Trenton, Lawrence and Sharon. The company has positive reports that their marl has more than doubled the crops of grain, potatoes and grass in those neighborhoods. About Vincentown they can see the good effects of marl for many years after its application.

From the General Freight Agent of the Camden and Atlantic Railroad we learn that seven thousand five hundred tons of White Horse marl have been carried on that road the past season, which has been used by farmers along its line.

The West Jersey Marl and Transportation Company, I. C. Voorhees, Superintendent, report their sales for the past year at thirty thousand four hundred and sixty-eight tons. It has been sent from the pits at Barnsboro, along the lines of the West Jersey Railroad, and sold in Gloucester, Salem, Cumberland and Cape May counties. Smaller quantities have been sold in Camden, Burlington and Mercer counties, and some has been sent by boat to Delaware. It is mostly used upon grass, potatoes and buckwheat, though a very large quantity has been used on fruit trees. This company sells large quantities of stone lime, which is thought to act well in mixture with marl.

Messrs. Dickinson Brothers, of Woodstown, report their sales for the year at thirteen thousand tons. This marl is all hauled away by teams and is used in Salem and the adjacent parts of Cumberland county. It is put on grass, potatoes, buckwheat, and a little on other crops. No better evidence of its value to the farmer could be given than this, that they draw it away in wagons and to distances where they can only get one load a day.

These in the aggregate amount to one hundred and thirty-four thousand seven hundred and thirty-four tons. No report has been received from the many localities in all parts of the marl region, where farmers dig it for their own use, and from farmers of the country around who draw their own supplies; but it altogether amounts to much more than the quantity given above.

In the country about the marl beds many farmers think they cannot farm without marl, and they use it most liberally. At greater distances off, and where the cost of transportation necessarily enhances its price, it is used much more sparingly. In such cases its effects are not so evident, and some persons consider it of but little if any value. Frequently its effects are not perceived at all the first year. Some four or five years ago a well-known citizen of Morris county was induced to try marl on his grass. The first year after he laughed at me for recommending marl, as it did not do his crops a particle of good. This fall he incidentally mentioned to me that his grass crop, where the marl was put, had been double what it was where barnyard manure was used, ever since the first year.

Those who are most successful in its use are very careful to have it dry and fine, so that it will spread evenly and uniformly over the whole surface of the ground. Much better effects are produced under this management than when the marl is spread while wet and lumpy. The addition of stone lime to the pile of wet marl must be of advantage by its slaking, and so heating and drying the marl, even if it has no chemical effect upon it; though the latter is claimed by its advocates. There would be a decided benefit in grinding the marl in a mill and making it as fine as possible. Common leached ashes, which have only about one and a half per cent. of phosphoric acid, and an equal quantity of potash, and a considerable quantity of carbonate of lime sell readily along all our navigable waters for about twenty cents a bushel, and never fail to satisfy those who buy them. The average price of marl is not more than ten cents a bushel, and in many places it sells for much less, it contains nearly ten times as much potash, and from three to eight times as much phosphoric acid; it does not contain as much carbonate of lime, but that is the cheapest constituent. The ashes are in very fine particles, and so in the best condition to dissolve, while the marl is in small grains, and at the best can dissolve but slowly. If the marl were equally fine with the ashes it ought to be worth at least four times as much. If it could be dried cheaply in the sun, or else by the use of unslaked lime, and then ground in a mill, it would pay to carry it much farther than it can be sent now, or it could be used in smaller quantities. There would be difficulty in grinding it between millstones on account of scattering grains of sand in it; but I have seen an English mill, made for grinding ore, coal, and even grain, in which the grinding is effected by the rapid whirl of a hollow iron cylinder with many cross rods in it. It was called Carr's Disintegrator; and a mill on somewhat the same principle is used in this country for comminuting glue. The subject of making the marl into fine dust or powder is well worthy the attention of our marl companies, as well as of the farmers, and I hope some mechanic will be found with the needed skill to provide for doing the work profitably.

Plumbago, Graphite or Black Lead.—This well-known and useful substance is found in small quantity in many places in northern New Jersey. There have been many specimens sent to the office of the survey, at different times, with a request for information as to their value. The answer has been in all cases, that as yet no specimens found in the State are sufficiently pure to work without first separating the earthy and rocky substance that is mixed with it; and that this, though attempted, has not been profitably done in our State. There is a long vein of this mineral which is four or five feet thick on land of Mr. Englemann, one and a half miles northeast of Peapack; it is also found in several places near Mendham, and there is also a very thick bed or vein of it near Bloomingdale. All these localities are in the Pompton Belt of our crystalline rocks, and very near its northwestern border. On the farm of Chas. Conover, near the road to Clinton and three quarters of a mile from High Bridge, a vein of quite pure plumbago has lately been opened in a shaft about twenty feet deep. Samples of it were sent to the office by Mr. Conover.

Works were erected at Bloomingdale to purify black lead. It was separated from the rock mixed with it by grinding and sorting in water. Good black lead was prepared in this way. The works were stopped from some financial difficulty. At Ticonderoga, in the State of New York, black lead is successfully separated from the stony substance in it, by grinding and sorting in the dry way, in a blast of air. The mineral there is richer than ours, but it is in much smaller veins. Black lead has also been purified by chemical processes, and for some purposes this is said to be available. Brodie's process requires the use of sulphuric acid, chlorate of potash and some other chemical substances to dissolve out the impurities of the native mineral.

Materials for Road Making.—The development of our resources is to a large extent dependent on the construction and maintenance of good roads. The first centres of that growth of our State, which has been so rapid for the last few years, were places where there were good roads, and since then the progress of improvements has been inaugurated by the making of dry and solid highways. Any place with bad roads, or those which are unfit for rapid driving or for heavy traffic any part of the year, cannot thrive. No man or no business can or ought to be supported where from one to four months of the year are lost for want of solid roads, if another place can be found where there is no loss of time from this cause.

Good gravel is found in all the middle and southern parts of the State, and excellent roads are being made of it. Turnpikes, county and township roads and even district roads are now graveled and made of the very best quality. The only requisites are to keep the road-bed dry, and its surface well covered with gravel, it is then always fit for travel.

In the central and northern parts of the State, gravel is not so universally distributed as in the southern counties. Gravel should be used wherever it is available, and where only earth or clay is to be found, the dependence must be in keeping the subsoil of the road-bed completely dry by means of tile or stone drains. If a ditch is dug in the middle of a road, and running lengthwise of it, and in this is put a draining tile or a stone drain, and then if the ditch is filled with the coarsest materials that can be got, and the upper surface shaped so as to not let the water stand on it, even the worst of materials will make a passable road. The benefits of thorough draining in a road, are beyond the expectations of even the most hopeful.

Stone roads are meeting very general approval in all places where there is travel enough to pay the interest on their cost. The first of these roads were built in Orange, where the trap rock of the mountain could be got in quantity and at little expense. The people there have gone on building these roads more and more every year, as they have proved their excellence, and at this time they have the best roads in the United States. The Essex County Road Board has wisely used its powers in covering all the main avenues which lead out from the city of Newark into the different parts of the county, with this material. The way in which the foundation is laid, was originated by Telford, and it is known by his name. The Road Board of Essex, occupying the most thickly settled part of the State, have been best able to begin this work, and they have set an example which sooner or later must be followed wherever there are roads on which there is much travel. Specifications and details of construction were given in the Geological Report of 1871.

Soils.—In almost all of Northern and middle New Jersey the soil is derived from the rock which underlies it. There are of course some exceptions to this, where deposits of sand and gravel appear to cover the surface; but even in these cases a close inspection will show that much of the material is like the rock underneath. The same principle holds also in the marl district and in the drift. The sand, the clay, and the loam which are found on the limestones of the north, are very different from those on the gneiss rocks, and these again are unlike those on the red sandstone. The marl region has its peculiar sands, clays and loams, and all these are different from those in the southern and southeastern parts of the State. Any classification of the soils under these common and well understood names is of very little use for comparison between soils from different geological formations. The chemical composition of the soils on these different geological formations is very different; while on the contrary the sand, clay and loam on the same formation resemble each other in composition, and these terms then express the mechanical condition of the soil and its relation to moisture, much more than its other qualities. On this account, we shall arrange the soils of the State for examination and study according to the rocks upon which they are found; and while the subject is only fairly begun, and we cannot give analyses of soils from all the different formations, still it is thought best to present representatives of our most marked varieties for present study and as a basis upon which to enlarge in future selections.

	Gneiss.	Limestone.	Slate.	Red Shale.	Marl.	Drift.	Drift (barren).	Miocene.	Alluvial.
Silica........	31.40	70.30	62.90	71.07	87.80	12.42	14.08	78.85	90.95
Alumina.........	6.91	10.73	16.18	9.27	3.88	2.46	1.47	9.38	2.49
Oxide of iron....	3.06	3.52	5.63	6.56	5.17	.77	0.58	3.68	.82
Lime..............	.64	.84	.48	.22	.20	trace	0.02	.23	.53
Magnesia	.65	.97	2.10	2.02	....	.06	0.09	.72	.29
Potash	1.07	4.34	4.06	.81	.44	.14	0.02	1.26	.18
Soda	.50	.37	....	.20	trace	.04	0.15	.42	....
Sulphuric acid.	.03	.02	.07	.03	.24	.08	0.05	.05	.08
Chlorine	.03	trace	trace	.01	....	trace	trace	.02	trace
Phosphoric acid	.13	.26	.32	.14	.19	.02	0.11	.07	.06
Organic matter.	8.55	6.26	6.55	5.00	....	1.74	2.29	3.00	8.40
Water......	1.55	1.54	1.55	3.80	2.56	.70	.35	1.10	.80
Oxide of manganese....		.45	.50	....	....	....	....	....	....
Sand and gravel	45.10	....	....	....	....	81.50	80.83	....	....
	99.62	99.60	100.34	99.13	100.48	99.93	100.04	98.78	99.60

The gneiss soil is fertile and not easily exhausted. It is mostly on hilly or mountainous land, and is so encumbered with loose rocks and stones that more than sixty per cent. of it is unimproved. The growth of wood upon it is valuable, and wherever it has been found sufficiently dry and free from stones to admit of cultivation, it has proved itself to be well adapted to general farming, and it can be kept in good condition with only moderate manuring.

The limestone soils have been cultivated with better success than any others in the State, and so well is their fertility known that they are all in use now. They produce large crops of our staple products, corn, wheat, and grass, without any manure except lime, and some of them are known to have done so for seventy years past.

The slate soils are well known for their rich and abundant yield of pasture and hay. They are all in profitable occupation, and like the limestone soils, they are not easily exhausted. The analysis shows them to be as rich in potash and phosphoric acid as the soils referred to; it also shows that they have much more alumina and of course more clay, and they have less lime.

The Red Shale and Sandstone Soils.—These soils have all been cleared and cultivated, and for years after the first settlement of the country they yielded paying crops. They became exhausted, however, and large tracts were left in common. Quick lime alone, with good tillage, has been found sufficient for their renovation. Very little of this soil is now unoccupied, and with a judicious use of commercial fertilizers much of it is yielding very large crops.

The Marl Soils.—These soils are really very valuable. Those directly over the beds of greensand marl are practically inexhaustible, and have been cultivated from the first opening of the country. In the intervals below and between the beds of greensand, the soil is not naturally as rich, and much of it has been worn out or never cleared. The analysis is that of an average soil, somewhat sandy, and rather deficient in lime. The application of lime to it is highly beneficial, and that, with the addition of greensand marl, brings it to a high degree of fertility. It costs a little more for fertilizers to bring this soil to a proper condition for yielding crops that return a profit; but it is light, easily tilled, and sure in its returns when well managed. There is some of this soil still unimproved, but it is fast coming under cultivation.

Drift Soils.—These soils cover a large part of southern and southeastern New Jersey. They have heretofore been held in large tracts, and except where iron furnaces or glass works were located they were uncleared till within a few years. There are at least a million acres of these soils adapted to the best farm purposes that are still in forest. The analysis shows them to be deficient in lime and low in potash and phosphoric acid, and experience has proved that with the slovenly and exhaustive farming of the first settlers, these soils were not profitable to work; but under a better system of farming, they pay well. Enriched with light dressings of lime, peat, marl and commercial fertilizers, they yield abundant and remunerating crops. Wheat, rye, oats, corn, potatoes, sweet potatoes and hay are raised in large crops, and fruits of all kinds do well. The cost of land and fertilizers is less than that of the land alone in the older parts of the State, the cost of tillage is very much less, and now that railroads and good wagon roads are extending through all parts of it, and that examples of its capabilities for improvements are to be seen at Winslow, Hammonton, Egg Harbor City, Vineland, Bricksburg, Glassboro, Clayton and many other places, the value of these lands for cultivation is demonstrated.

The Miocene Soils.—These soils are the high and retentive soils of Cumberland and Salem. They have been cleared early and have yielded well for a time, but under the old system of exhaustion they gradually wore out. The use of lime has done much to renovate them, and with that and calcareous and green-sand marls, they are easily and at moderate cost brought up to more than their original fertility. The analysis shows them to be low in lime, but rich in potash.

Alluvial Soils.—This class of soils includes all those along the ocean and other tide-waters, which are not more than ten or fifteen feet above that level. They are very productive and easily tilled, and have been in cultivation from the earliest settlement of the country. The soil analyzed as above has been cropped for fifty years without any manure whatever, and does not yet show any signs of exhaustion. It is a sandy soil, and the only element in which it abounds, is lime.

APPENDIX.

[HEMATITES.]

BIRD MINE NEAR CLINTON.

The following analysis shows the composition of the average ore as mined. The sample was selected by Mr. Conover, and sent to the State Laboratory:

Insoluble in acid,	21.40
Sesquioxide of iron,	57.88
Alumina,	4.05
Lime,	.16
Magnesia,	1 08
Oxide of manganese,	.60
Sulphur,	00
Phosphoric acid,	3.46
Water,	11.05
	99.69
Metallic iron,	40.50
Phosphorus,	1.51

The large percentage of insoluble matters is owing to the rock and earth, which washed samples would not show. The very large amount of phosphoric acid is also remarkable.

PUBLICATIONS OF THE NEW JERSEY GEOLOGICAL SURVEY.

Geology of New Jersey, 899 pages large octavo, illustrated by 108 photolithographic engravings and woodcuts, and six mine maps; and accompanied by a portfolio containing the following maps, in sheets:

1. Azoic and Paleozoic Formations, including the Iron-ore and Limestone districts; colored; scale 2 miles to an inch:
2. Triassic Formation, including the Red Sandstone and Traprocks of Central New Jersey; colored; scale, 2 miles to an inch:
3. Cretaceous Formation, including the Greensand Marl Beds; colored; scale, 2 miles to an inch:
4. Tertiary and Recent Formations of Southern New Jersey; colored; scale, 2 miles to an inch:
5. Map of a Group of Iron Mines in Morris county; printed in two colors; scale, 3 inches to 1 mile.
6. Map of the Ringwood Iron Mines; printed in two colors; scale, 8 inches to 1 mile:
7. Map of the Oxford Furnace Iron-ore Veins; colored; scale, 8 inches to 1 mile:
8. Map of the Zinc Mines, Sussex county; colored; scale, 8 inches to 1 mile:

Price of the book and portfolio of maps, $6.50.

Geology of New Jersey, as above, without portfolio of maps, but containing a folded and colored map of the State, on a scale of 5 miles to 1 inch. Price $4.00.

Single copies of either of the above maps, colored and in sheets, 50 cents.

Geological Map of New Jersey, on a scale of 2 miles to one inch; colored and mounted on rollers. It gives the Geology of the State the same as Maps 1, 2, 3, 4, in the portfolio, and is essentially these combined in one map. Size 5½ by 7½ feet. Price $8.00 per copy.

The prices are fixed to merely cover the cost of paper, printing and binding; the expenses of the Survey and preparing book and engravings being paid by the State.

These publications can be had from Prof. Geo. H. Cook, State Geologist, New Brunswick, on remitting the price, or through the booksellers. They are also kept for sale at these prices by M. R. Dennis & Co., of Newark, and D. Van Nostrand, of New York city.

Annual reports for the years 1869, 1870, 1871 and 1872 have also been printed. These can be had by application to the State Geologist.

The publications are in the followin public libraries, where they can be consulted:

In all the State Libraries; in some other of the large public libraries in different parts of the United States, and in all the public libraries in New Jersey and the cities of New York and Philadelphia. It is also in the offices of most of the County Clerks of New Jersey.

INDEX.

Page.

Analysis of ore from Kahart Mine ... 26
  Jackson Mine ... 27
  Swayze Mine ... 34
  Hacklebarney Mine ... 36
  David Horton Mine ... 40
  Ringwood Mine ... 53
  Van Syckle's Mine ... 55
  Stoutenburgh Mine ... 58
  New Mine, Oxford Furnace ... 61
  Pequest Mine ... 78
  Hoit Farm Mine ... 80
  Henry Tunnel ... 79
  Kishpaugh Mine ... 83
  Howell Farm Mine ... 86
  Bird Mine ... 119
  Cement Rock ... 108
Attraction, lines of intersecting ... 60
  kinds of ... 93
Azoic rocks, age of ... 15
  description ... 17
  region, division into belts ... 11
  rocks, origin of ... 19
Bennet, E. J., quarry of ... 100
Black lead ... 112
Boring for glass sand ... 105
Boundary line, northern ... 10
Brown stone ... 101
Building stone ... 99
Cement ... 107
Clays, where to be found ... 103
  mode of searching for ... 104
Compass, miner's, described ... 91
Copper ores ... 98
Copperas Mount, mines near ... 48
Cream Ridge Marl Transportation Company ... 110
Diamond drill for prospecting ... 26
Diamond drill, exploration with ... 95
Diamond drill used ... 51
Dip, explanation of term ... 16
Drainage of lands ... 9
Forests on the Azoic Formation ... 11
Forest on drift soils ... 117
Flanders, glass sand at ... 105
Glass sands ... 105
Gneiss for building stone ... 101
Gold and silver ores ... 99
Granite for paving blocks ... 100
Graphite or black lead ... 112

Page.

Green sand marl.... 109
Hematite.... 88
Hematite, mode of searching for.... 97
Hydraulic lime.... 107
Iron ore, probable origin of.... 19
Iron ore, searching for new beds of.... 90
Iron mines, statistics of.... 21
Iron mines, list of, with notes.... 22
Iron works, historical notice.... 21
Laurentian rocks in New Jersey.... 15
Lime, manufacture of.... 106
Limestones for lime.... 105
Marl, green sand.... 109
Marl, green sand, use and value of.... 112
Marl transportation companies.... 109–111
Marl, statistics of.... 109
Map and sections described.... 19
Mines, iron, list of, with notes.... 22
  Albertson Mine.... 85
  Allen Mine.... 45
  Andover Mine.... 88
  Asbury Mine.... 55
  Axford Farm Openings.... 63
  Baker Mine.... 43
  " " N. E.... 44
  Bald Pate Mine.... 62
  Banghart's Mine.... 56
  Barnes' Mine.... 39
  Barton Mine.... 78
  Bartleyville Mine.... 59
  Beach Glenn Mine.... 47
  Beattyestown Mine.... 59
  " " (hematite).... 89
  Bernardsville Mine.... 24
  Bethlehem Mine.... 55
  Bird Mine, analysis of ores of.... 119
  " " (hematite).... 89
  " " (Sussex county).... 88
  Board Mine.... 52
  Boss Mine.... 66
  Botts' Farm Opening.... 49
  Brookfield or Waterloo Mine.... 64
  Brotherton Mine.... 43
  Bryant Mine (Randolph township).... 43
  " " (Warren county).... 63
  Buck's Hill Shaft.... 63
  Budd Mine.... 32
  Budd and Hunt's Tract.... 69
  Butler Mine.... 28
  Byram Mine.... 43
  Canfield Mine.... 41
  Canfield phosphate iron ore.... 43
  Canistear Mines.... 70
  Carbon Mine.... 40
  Cedar Hill or Ten Eyck Mine.... 89

Page.
Mines, Chapin and Lommasson Diggings 60
  Charlotteburgh Mine 49
  Chester Hotel Property 33
  Cobb or Splitrock Mine 47
  Cokesburg Mine 29
  Collis Farm Shafts 83
  Combs Mine 41
  Confucius or Creagor Mine 61
  Connet Mine 24
  Connor Foulan Mine 43
  Cooper Mine 41
  Creagor or Peach Orchard Mine 36
  Creamer Farm Openings 38
  Dalrymple or Carbon Mine 40
  " (Solomon) Mine 41
  Davenport Mine 66
  Davis Mine 85
  Deat's Farm 81
  Decker Farm Pits 51
  De Camp Mine (Chester) 38
  " " (near Powerville) 50
  De Hart Mine 49
  De Bow Mine 26
  " (Ryerson's) Mine 27
  Dickerson Mine 43
  Dickinson Mine 59
  Dodge Mine 65
  Dolan Mine 46
  Duffee Mine 66
  Egbert Mine 62
  Erb Mine 43
  Eureka Mine 64
  Evers Mine 43
  Excelsior Mine 64
  Fisher or Beattyestown Mine 59
  Ford Mine 66
  Fox Hill Mine 30
  Franklin Mines 88
  Frase Farm Diggings 63
  Fraser Mine 66
  French's Mine 66
  Fritts Farm 56
  Garrison Farm 85
  Glendon Mine 88
  Goble Mine 66
  Gould's Farm Openings 51
  Green Mine 71
  Greenville Mine 48
  Green's Mine 88
  Green Pond Mine 48
  Greer Farm Openings 68
  Gulick Mine 36
  Hackettstown, prospecting near 63
  Hacklebarney Mine 35
  Hacklebarney and Chester range of mines

Page.
Mines, Haggerty Mine 67
Haggerty's Diggings 87
Hardin Farm Openings 32
Hedge's Mine 37
Henderson Mine 43
" Farm Openings 70
Henry Tunnel 78
Hibernia Mines 47
High Bridge Mines 29
Hopewell Forge Tract 68
Hopler Farm, or Bartleyville Mine 59
Horton (Daniel) Mine 38
" (David) Mine 39
Hickory Hill Mine 46
Hoit Farm Mine 80
Howell Farm Mine 85
Hude or Stanhope Mine 67
Huff Mine 46
Hunt or Pidcock's Mine 56
Hurdtown Mine 65
Irondale Mines 43
Jackson Mine 26
Jackson Hill Mine 43
Janes Mine 24
Jennings and Rutherfurd line 69
Johnson Hill Mine 46
Johnson's Diggings 62
Kahart Mine 25
Kanouse Mine 28
Kimble Farm 68
King, Charles, Mine 43
King Mine 43
King, G. D., Mine 43
Kishpaugh Mine 82
Lanagan Mine 26
Lanning Farm Openings 60
Large's Mine 28
Lawrence Farm Diggings 68
Leak Mine 38
Lebanon, mining near 28
Lewis or Herrick Mine 41
Little Mine 74
Livsey's Mine 87
Maring Farm 87
Marble Mountain, mine on 72
Marsh's Mine 59
McFarland Mine 43
Meriden Mine 47
Miller Farm Openings 56
Millon Mine 43
Mitchell Mine 61
Monks Mine 52
Mount Hope Mines 45
Mount Olive Mines 59
Mount Pleasant Mine 44

Page.
Mines, Naughtright Mine 58
  Ogden Mines 68
  Old Furnace Mine 29
  Oxford Furnace 61
  Pardee and Canfield mine of 48
  Pequest Mine 76
  Pidcock's or Hunt Mine 56
  Pike's Peak Mine or Stony Brook Mine 51
  Pleasant Grove Openings 56
  Pochuck Mine 88
  Pompton Mine 26
  Potter Farm 85
  Pottersville, mining in vicinity of 30
  Powerville, mining near 49
  Pyle's Farm Openings 63
  Randall Hill Mine 43
  Rarick Farm Diggings 31
  Rarick Farm, Schooley's Mountain 59
  Raub's Farm 75
  Redell Mine 74
  Richards Mine 45
  Righter Mine 47
  Ringwood Mines 52
  Rockport, diggings near 62
  Roseberry Mine 73
  Roseville Mine 88
  Samson Mine 38
  Schaeffer Farm 87
  Scofield Mine 65
  Schuler Openings 72
  Scrub Oak Mine 43
  Searle's Mine 62
  Segur and Wright, lease 70
  Shaw Mine 85
  Sharp's Diggings 59
  Shiloh, hematite near 89
  Shoemaker's Diggings 74
  Sickles Mine 67
  Silver Mine 67
  Sigler Mine 47
  Skellenger Mine 33
  Smith Mine, Schooley's Mount 59
  Smith or Cascade Mine 66
  Smith's Mine 81
  Splitrock or Cobb Mine 47
  Splitrock Pond Veins 47
  Stanhope Mine 67
  Stevens Farm or Excelsior Mine 64
  Stiff Farm 84
  Stony Brook Mine 51
  Stoutenburgh Mine 57
  Sulphur Hill Mine 88
  Swayze Mine 33
  Swedes Mine 46
  Tar Hill Mine 88
  Taylor Mine 25

Page.
Mines, Teabo Mine........ 45
Ten Eyck's Diggings........ 71
Tichenor's Diggings........ 47
Titman Shaft........ 76
Topping Farm Diggings........ 32
Tracy & Crane Farms........ 70
Van Syckle's Mine........ 55
Warrenville, mining near........ 63
Washington Forge Mine........ 44
Waterloo or Brookfield Mine........ 64
Wawayanda & Green Mines........ 71
Welch & Inschow Lots........ 84
Weldon Mine........ 65
Weldon (Lower) Mine........ 65
White Hall Mine........ 56
White Meadow Mine........ 47
Williams Mine........ 70
Woodhull Mine........ 32
Wynokie Mines........ 52
Young Farm Diggings........ 63
Miners' compass, how to use........ 94
Mines, depth of........ 43
Musconetcong Belt, boundaries of........ 14
" " ore-bearing rock in........ 71
Offsets or faults........ 17
Ore bearing rock........ 64
Passaic Belt described........ 13
" " mines in........ 28
Pemberton Marl Company........ 110
Pequest Belt described........ 15
" " mines in........ 72
Pitch, term explained........ 16
Port Murray, mines near........ 61
Ramapo Belt, boundaries of........ 12
" " iron mines in........ 24
Road Making, materials for........ 113
Rock containing iron ore........ 64
Rutherfurd and Scranton Tract........ 69
Ryerson, M. J., quarries of........ 99
Sandstone for Building........ 101
" quarries of........ 102
Soils, classified........ 115
" chemical composition of........ 115
Silver ores........ 99
Squankum Marl Company........ 109
Squankum and Freehold Marl Company........ 109
Strike, term explained........ 16
Telford roads........ 114
Titanic acid, large percentage of........ 55
Veins, iron continuity of........ 44
Vincentown Marl Company........ 110
West Jersey Marl and Transportation Company........ 110
White Horse Marl........ 110
Woodstown Marl........ 111
Zinc ores........ 97
Zinc ore, mode of recognizing........ 98